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Packing for Piston Rods and Valve Stems.

By Lewis F. Lyne.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The subject of this paper may at first appear to some engineers to be rather a tame one, but when we consider the important relation it bears to the economical working of the steam engine, we are at once led to consider it as one of the most important. In a general sense, the piston-rod packing causes more trouble than any other part of the engine. Since piston-rod packing then is so essential, and requires so much care, we may very properly ask the following questions: What are its requirements and of what should it consist in order to best meet those requirements? In order that we may properly understand the subject before us, it will be well to consider for a few moments the facts, as recorded, relating to the inventions of piston rods and packing. The piston engine was first invented in 1710 by Thomas Newcomen and John Cawley, of Dartmouth in Devon. This engine was single acting, and passed through numerous stages of improvement until the year 1782, when James Watt invented and built a double-acting steam engine. Previously, however, Watt had made use of the stuffing box for packing piston rods, the invention of which for steam engines has been attributed to Sir Samuel Morland, but it was probably used some years previously upon pumps. In a letter to Smeaton, dated April, 1766, Watt explains the difficulties encountered in making a tight connection, allowing the piston rod to move freely. In the engine which was built in 1782, Watt, as a result of his previous experiments, bored a cavity in the cylinder head similar to those in use at the present time, the bottom of which was beveled at an angle of about 60° to a line parallel with the face of the cover, as shown in Fig. 1. The hole in the bottom was slightly larger than the piston rod, so as to prevent the rod from touching any metal. The piston rod was very nicely polished, a point upon which Watt was very particular, and the sharp angle of the bottom of the stuffing box was for the purpose of causing the packing to close tightly around the rod. For the use of fibrous packing this is doubtless the best form.

For packing he used coils of hemp or tow with a washer of leather at the bottom (afterwards abandoned), which were constantly lubricated with tallow. The tallow was derived from lumps of suet placed in a cavity in the gland, the same as upon the present marine beam engines.

In attempting to answer the question before us, I must first call attention to the fact that the requirements of a piston-rod packing are to permit the rod to move freely in all directions with the least friction possible, yet without allowing the steam to escape. Second, that the packing must be of a substance, or material, which will secure this result, and possess the greatest durability. After the adoption of hemp or tow, Watt found that the piston rod would very soon lose its bright surface and become full of scratches, appearing as if it had been draw-filed with a coarse file, and so we find piston rods to-day. Many substitutes for hemp have been invented, which have in many instances, after due trial, been abandoned for the original material and methods. All fibrous material contains more or less grit which, sooner or later, will surely destroy the glazed surface of the rod, causing ridges to be rapidly worn, destroying the packing and causing undue friction.

I remember a case where a locomotive having piston rods newly packed with hemp would not move with a boiler pressure of 60 lbs. with the throttle wide open. The cause was the excessive friction in the stuffing boxes. A series of experiments for the purpose of determining the loss of power through the friction of piston and valve rods, in passing through stuffing boxes, would confer a boon upon engineers. In some instances I have found it necessary to repack a piston-rod every other day, until the rod was taken out and turned off. There are, perhaps, some who will doubt me when I assert that I never saw an engine (nor do I believe that there ever was one) in which I could not find some evidence that the piston rod did not travel in the center of the cylinder.

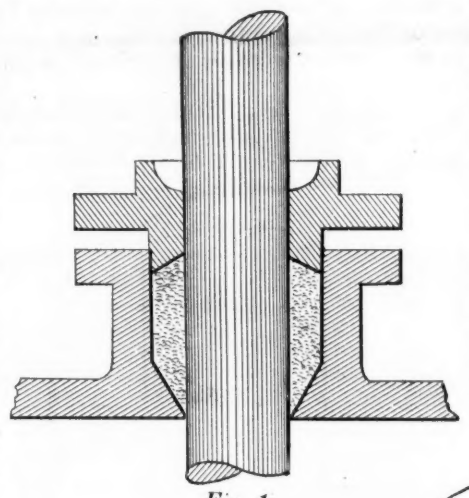


Fig. 1.

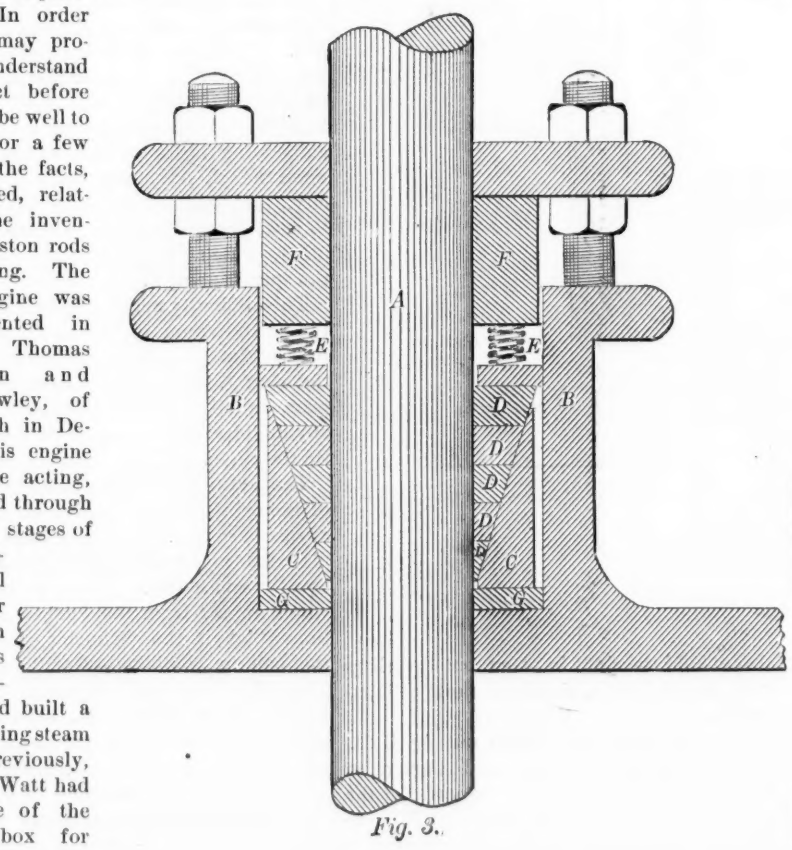
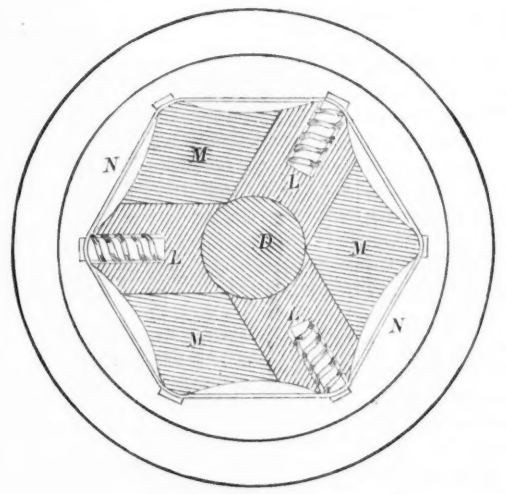


Fig. 3.



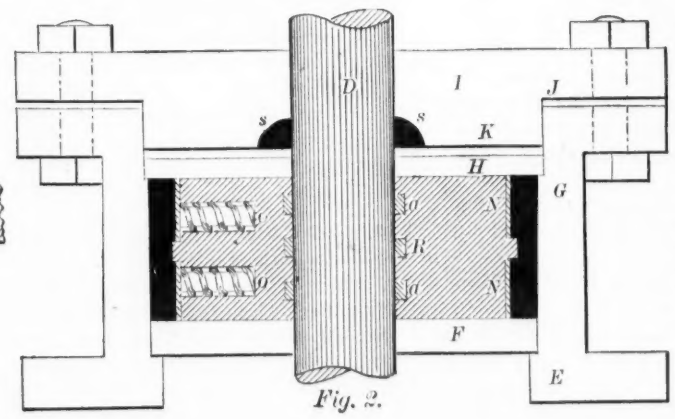


Fig. 2.

I lately had occasion to examine a beam engine having a cylinder 110 inches in diameter and a stroke of 12 feet, in which the piston rod was 12 inches in diameter, was out of the center of the cylinder about $\frac{8}{16}$ths of an inch, and varied in diameter about $\frac{3}{16}$ths of an inch, besides it was neither round nor straight, and ran at a speed of 372 feet per minute.

It would be a very difficult matter indeed to keep a fibrous packing tight under the foregoing circumstances. In the following remarks I refer more particularly to horizontal engines. In fitting up pistons, there are numerous operations, all of which, if not accurately performed, have a tendency to throw the rod out of the center. To illustrate: The lathe center may not run exactly true, and this is generally the case, so that when the rod is finished, and the piston trued up, by placing it upon stationary centers, a variation will be revealed. Again, granting that the piston and rod are exactly true, in planing up the cross head there are few men who will turn out an absolutely true piece of work; it will be inclined to one side or the other. If gibs are to be used upon the cross head, it requires very close work to align them so as to guide the piston rod exactly in the center of the cylinder. I remember that, while an apprentice, the boss gave me a pretty severe lecture one day for boring a gland so that it would shake a little upon the rod, and when I asked why it should fit better, I was told that "it was to hold the piston rod in line with the cylinder." I am convinced that a piston and rod supported at one end in the bore of the cylinder, while the other is guided by the cross head following the guides, should have no rigid bearing between these two points. Piston rods that have been long in use will, as a rule, be found smallest in the middle, and are of an oval shape at the ends; as, for instance, the follower end of the rod will be worn most upon the bottom, while the crank end will be most worn upon the top. This is owing to the constant inclination of the piston to wear downward, and the cross head to wear upwards, as, for instance, upon a locomotive, while running ahead, the cross head bears almost constantly against the top guides, dropping only at the ends of the stroke. In running backwards the cross head does not rise, but bears constantly upon the bottom guides. In either case the wear of the piston is constantly downward.

This state of things causes an angular movement of the piston rod through the stuffing box, speedily destroying the packing. It is customary upon locomotives when putting in a new piston and rod to set the piston about a thirty-second of an inch high, thus destroying the perfect alignment at once. The cross head which is easily accessible, and where gibs are used, can be raised while the piston is allowed to run until it will not go any longer.

Keeping this illustration in mind, it will readily be seen that if there is not enough room through the stuffing box for the rod to move freely, it will make room for itself.

If it were possible to put a rod and piston exactly in line with the bore of the cylinder, they would not remain so for any definite length of time for the reasons alluded to. To allow a rod, like the one just described, to move freely without causing a leak, is the chief reason that so many inventions have been made and patents taken out, resulting in over seven hundred failures without accomplishing the desired object. So long as a piston remains in line, there is little difficulty in keeping it tight with a good quality of fibrous packing which is entirely free from grit, but as soon as the glazed surface upon the rod is abraded, or the parts get out of line, it begins to cut, and constant trouble may be expected. I have seen new piston rods nearly destroyed within forty-eight hours after they left the shop. This was caused by the use of hemp that had gritty substances in it. For this and similar reasons, the attention of early engineers was *directed to the substitution of some other material for hemp.* It should be borne in mind that while the cause of the cutting of the rod is generally attributed to the hemp packing, it is more frequently caused by the parts getting out of line, and the rod coming in contact with the metallic surfaces of the gland or stuffing box All the little particles of metal removed by cutting are caught in the hemp packing and assist in destroying the rod. Accordingly, canvas, rubber, leather, wood, metal, metal filings and turnings, soapstone, asbestos, and combinations of different substances were used with a more or less degree of merit, so that, at the present time, piston-rod packing may be classified under two different heads, viz.: vegetable or fibrous, and metallic. To describe the advantages of, and objections to, the different fibrous packings, would require more space than can here be allowed. We have now arrived at a period where it seems that an engine or machine is expected to develop the greatest power, wear the longest, and require the least expenditure. The fact is, fibrous packing does not last long enough, so attention is directed to metallic packing.

It is an erroneous idea, on the part of some, to suppose that metallic packing is a new thing, and we will confine our attention to the origin (so far as known) and the development of metallic packing. The first metallic packing of which we have any record was invented by Cartwright, Nov. 11, 1797. The engine to which it was applied was constructed to use the vapor from alcohol instead of water. Cartwright's packing consisted of flat metallic plates cut into segments, which were pressed against the rod by steel springs in the shape of the letter U.

This packing was afterwards much improved by Barton, and is represented by Fig. 2.

The following description is taken from Tredgold's "Treatise on the Steam Engine":

"*D* is the piston rod, *E* the box with a ledge for the cast iron plate *F* to rest on, and another above it to receive the cast iron plate *H*. The cover *I*, of the box is secured by bolts in the usual manner (in use at the time), with plates of lead in the joints *J* and *K*, for the purpose of making the joints closer. The three principal metal blocks *L*, embrace the piston rod *D*, and three wedging blocks *M*, fill up the spaces between them. Two thin hoops *N*, of steel, firmly riveted together at their ends, surround the outside of the blocks, binding upon the rounded exterior of the blocks, and these angles are left on in the middle to keep the hoops in their places. At each of the exterior angles of the blocks *L*, there are two spiral springs *O*, fitted to cylindrical holes, and also provided with cylindrical pins as those of the piston. By these and the elastic hoops the blocks *L*, are strongly pressed towards the piston rod Two other hoops *a*, of elastic steel cut across, are inserted in two grooves to be in contact with the rod, and serve to close the joints more perfectly. They are fixed in a similar manner to the rings round the piston rod before described. The middle groove *R*, is formed between the two others to receive grease, and a circular cavity *s*, is also made around the hole in the cover for the same purpose. In constructing, the blocks *L*, should be parallel, otherwise the wear will be irregular, and the springs will soon be ineffective. The blocks *M*, should not wear unless the piston rod wears, and perhaps it will not be steam tight unless assisted by a hemp packing behind the hoops *N*."

It will be observed that this packing is designed with the expectation that the piston rod will always move in line and in the same plane with the piston and cross head. There are no provisions for allowing the rod to rise or fall, but the packing itself is intended to grasp the rod not touching the walls of the stuffing box. Should there be any deflection of the piston rod from a straight line as before described, it would cause a derangement of the parts, as the packing cannot tip. In practice the springs are insufficient to exert a uniform pressure, for as fast as the metal is worn away the springs are weakened, there being no way to set them up, and the lubricant used very soon sticks the segments and plates fast so that they will not work.

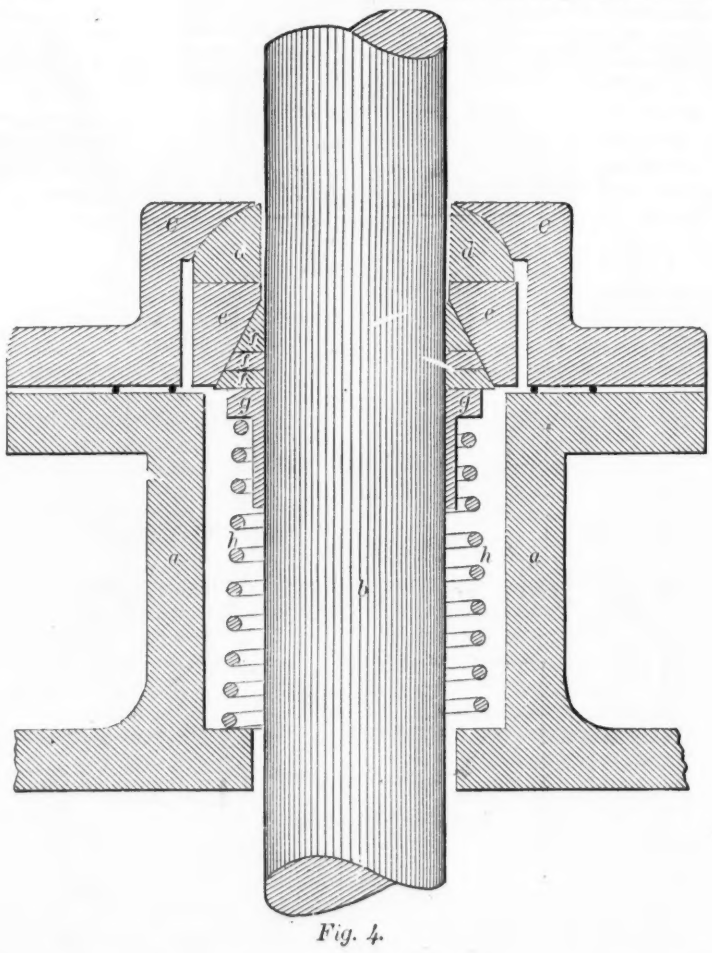


Fig. 4.

A thin wiry edge forms upon the ends of the blocks at their sides as they are worn away, which causes the parts to open, thereby causing a leak and much annoyance.

Three flat metal rings were next tried, similar in construction to the old-fashioned piston spring packing as used upon locomotives, only the springs were applied outside. The trouble with this plan was, that while in pushing the rings apart as in a piston they worked well, but when placed in a stuffing box and pressed together, the wear caused the ends of the rings to meet, thus preventing them from closing tightly around the piston rod, which greatly limited their durability. Difficulties were encountered, such as the parts getting out of line, etc.

Allen and Noyes, Nov. 6th, 1847, took out a patent which developed some new features, and is represented by Fig. 3. *A* is the piston-rod; *B*, a section of the cylinder head; *C* is an an iron sleeve fitted to the stuffing box and tapered on the inside as shown. Babbitt metal rings, represented by *D*, are turned to fit the sleeve *C*, and bored to fit the rod *A*. Each ring is cut so as to allow it when worn to close around the rod. These rings are pressed down by the springs *E*, which are held in position by the cap or gland *F*. It will be noticed that the same principle adopted by Watt (of the conical-shaped cavity into which fibrous packing was pressed, thereby causing it to close around the rod) is used in this packing—only metal is used instead of fiber. The trouble with this style of packing was that it was too rigid, making no allowance for the deviation of the rod from a straight line; moreover the pressure of steam would press the rings back against the springs which were too weak to resist so great a pressure. If the springs were made strong enough to resist the pressure of the steam, they would cause the rings to wedge too tightly in the conical-shaped cavity. Practically these springs have been abandoned, and a ring of fibrous packing used instead. The same principles embodied in this packing have since, with some slight alterations, been patented over and over again. The inventor claims to allow for a direct lateral movement, but practically the lubricant soon sticks the iron ring fast so that it will not move. Steam is prevented from escaping by a composition ring *G*, having ground joints.

Other improvements followed the one described, and F. J. Johnson took out a patent February 10, 1863, in which steam was first used to close the rings around the rod, and also to hold the rings in place, but the rings were of a flat form, similar to those of Cartwright.

Another patent was taken out April 21, 1874, by Messrs. Gilmore and Carter, in which a ball joint was introduced for the first time, which permitted the packing to tip and accommodate itself to a slight angle of the rod, also to a lateral movement. The ideas embodied in this packing were good, but the inventor did not go far enough. The two ball joints at the top and bottom, as constructed, could not work in harmony with each other, and there was no way of compensating for wear. A packing allowing a free movement in any direction was finally invented by one Martin Schneble, June 11, 1878.

This packing embodies the conical shape of Watt, only the cones are reversed, and the spring, or pressure, to hold them is put on the steam side instead of outside, the operation of which will very readily be understood by referring to Fig. 4, where *a* represents a sectional view of a cylinder head, *b* the piston rod, and *c* a cap to hold the packing. This cap is fastened to the cylinder head by means of studs, or bolts; the hole is bored larger than the rod, and the inside is turned to make a ball joint for the reception of the brass ring *d*. A cast-iron ring *e*, is bored, tapering as shown, making a flat sliding joint against the ring *d*, while the white metal packing rings *f*, are turned to fit the inside of the ring *e*, making steam-tight joints upon each other. These rings are cut through upon one side, and a small section taken out, so as to allow about $\frac{1}{4}$th inch opening. The brass collar *g* is attached to the end of a spring *h*, by which it is pressed against the packing rings holding them in position.

I claimed at the outset that a piston-rod packing should allow the rod to move freely in all directions, at the same time preventing the escape of steam. It should be made of a material which will not cut or wear away the rod.

I find by investigation that the packing represented by Fig. 4 appears to possess these requirements, as will be understood from the following description: The holes through the cap *c*, and cylinder head *a*, are much larger than the rod *b*, so that by the application of the sliding joint between the rings *d* and *e*, the rod can move freely up and down, while the ball joint, between *d* and *c*, allows the rod to work at an angle; thus by this combination the difficulties before alluded to are entirely overcome.

Another valuable feature is that by making the area small at the end of the rings *l*, and the conical cavity at a proper angle, the steam cannot cause unnecessary friction upon the piston rod, and the resistance is found to be a great deal less than with fibrous packing. The rings *f*, if made of lead or similar soft metal, will necessarily catch grit and wear away the rod, but when made of a proper mixture of anti friction metal exhibit great durability. I have known a set of this packing applied to a locomotive to run a distance of 118,677 miles without being touched by the engineer or any other person. The piston rod at the end of that time was reduced in diameter less than $\frac{1}{64}$th of an inch, and was highly polished. I noticed by an examination of some packing, embodying the foregoing principles, and used upon the 6th Ave. elevated railroad in this city, that some of the rings *f*, are inclined to wear more upon one side than upon the other, which is owing to the deflection of the spiral spring *h*.

This difficulty may be easily overcome by the introduction of a ball instead of the present flat joint between the collar *g*, and the ring *f*, which will allow the spring to push equally on all sides, thus removing any inclination on the part of the spring to tip the rings.

The addition of the ball and sliding joint, of Schneble, to the packing of Cartwright, as shown in Fig. 2, when applied in principle to flat rings upon large engines, has proved equally successful. From observation, it would appear from the foregoing investigations that if the Schneble invention (of the ball in combination with the sliding joint allowing a free movement of the piston rod in all directions) had been applied to some other segmental packings they too might have proved successful.

Letters From Practical Men.

Notes of a Foreman.—Castings.

Editor American Machinist:

Next to the unreliability of men, is the unreliability of the materials with which a foreman has to deal. I will speak here of but a single material—cast iron, or rather castings, and I don't feel able to do justice to that.

Castings are a constant element of uncertainty in the machine shop. You can't tell when you will get them, nor whether they will be all right when you do get them. If they are right, you can't tell whether the next lot will be like them. Castings bring a foreman into frequent scrapes. Promise to have a job finished at a certain time, and then be disappointed about getting your castings, and see where you are. When you promise work, always make your promise contingent upon the timely receipt of your castings. There is another interesting case where you try to use doubtful castings, and after expending a lot of work upon them, you have finally to throw them away. That makes a fellow feel cheap. These doubtful

castings are a fine means of discipline to the foreman, and as he uses them they develop decision of character, or vacillation and instability. My advice is, if a casting is questionable, send it back to the moulder, and let him have the benefit of the discipline which it affords.

I don't believe I am betraying any secret when I say that, while there are some blacksmiths to whom a machinist is willing to accord most of the attributes of a common humanity, I have never found a machinist who had any respect for a moulder. Why should he have any? Complain to a moulder of any defect in a casting, and see if you can rely upon anything which he may assign as the cause of his failure; or, what is more to the point, see whether you can depend upon his ability to remedy the fault in the future. If a moulder has a bad casting, he can merely tell you, as a woman does when her bread is heavy, that he had "bad luck" that time, and that's the end of it.

The constituency of the AMERICAN MACHINIST should include all classes connected with the production of machinery; not merely the machinist, the greasy (I beg pardon) worker in iron and steel, but equally with him the proprietor or leading mind of every shop; the draughtsman and designer, the pattern maker, the moulder, the blacksmith, and the boiler maker. But who supposes that a moulder ever saw the inside of a mechanical journal? I have, indeed, seen some articles upon moulding in the papers, but they were not written by a moulder, and I never knew a moulder to read them. If I were looking for a promising field of practical philanthropy, and had the time and means to occupy it, I would organize a Society for the Diffusion of Knowledge Among Moulders. Here is an inviting opportunity in which glorious results are to be achieved, and the blessings of prosperity await whoever will earnestly engage in it.

No one need misunderstand me. I write, after a fashion of my own, my convictions. I honor skill in other spheres of industry as sincerely as in my own; but I believe that the ways of moulders are somewhat slipshod. I do not believe that moulders do their best always. I do not believe that the conditions of production in the foundry are necessarily uncertain and uncontrollable. Where moulders are sufficiently interested, they rarely lose castings. A large or elaborate casting, whose production is considered a great achievement, is almost uniformly a successful one.

Why may not a moulder be an enthusiast in his calling even as other men? Why may he not know the fierce joy of earnest and absorbing toil? If a moulder would learn to do that, I don't believe he'd trouble me so much. If the moulders will rise up in meeting and confess their sins and promise to do better, I will try to forgive, though I can't forget.

Troy, N. Y.

HINTS FOR BUILDERS OF STEAM VESSELS.

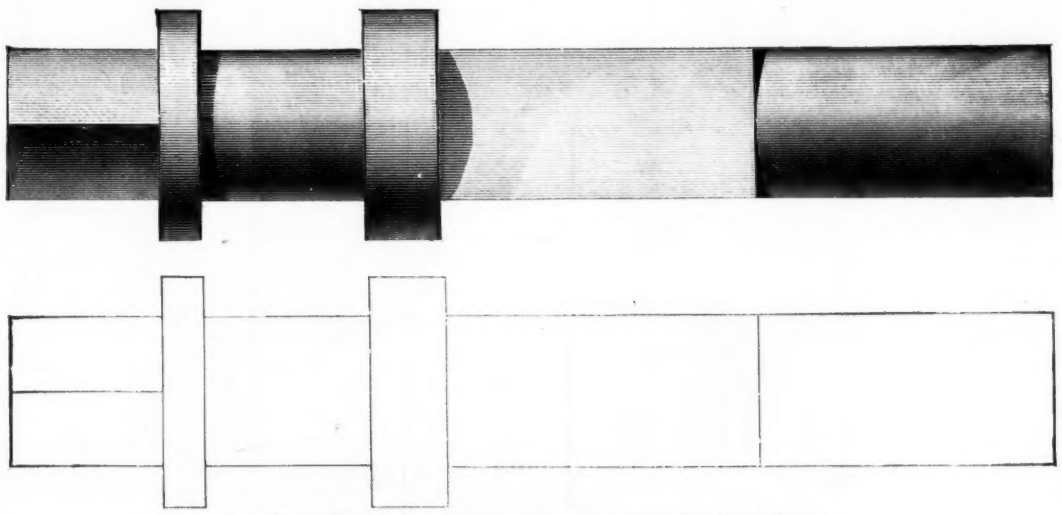
Editor American Machinist:

With your capital remarks about steamboats, etc., on page 8, No. 46, permit me to heartily agree, except one word—"joiners," in last sentence but one. A joiner (with all due respect to the craft, and may they wax rich and fat), is one of the worst nuisances that can infest a steamboat, and should on no account be allowed on board without a ticket. We all know him. He is the man whose holocaust of victims cry *anathema* from ten thousand watery graves at the bottom of every river and lake and sea. Till steamboat men learn to let him and his kindling wood alone, and not put a foot of lumber aboard their craft, except, possibly, in the furniture (which is too isolated to burn much), we shall have frequent recurrence of last summer's dreadful experiences.

It is earnestly to be hoped that the companies building the iron steamers of which you speak will not imitate the constructors of so-called fire-proof buildings on shore, and put in just enough wood to melt and warp down all the metal surrounding it. It is also to be hoped that said boats will not be made "unsinkable," by a few alleged water-tight bulkheads, with every convenience in the way of doors through and open hatches between them. Of course, a few separate compartments make a vessel safer, but the only absolute safety lies in making up the shell of hundreds or thousands of impermeable cells. If a boy wanted a good toy boat, that the other boys couldn't burn or sink, the pieces of which would float off if they smashed it, he'd whittle it out of some cellular substance, like a piece of pumice stone. A tin cup makes an excellent little boat, and a still better one, with a partition or two soldered across inside—till something happens to it. Don't let us have any more tin-cup boats.

OBERLIN SMITH.

Bridgeton, N. J., Nov. 9, 1880.



TWO SPECIMEN MECHANICAL DRAWINGS OF THE SAME OBJECT.

A FEW HINTS CONCERNING MECHANICAL DRAWINGS.

Editor American Machinist:

I have noticed in your paper, at various times, articles from draughtsmen, regarding the relative positions on the paper of the elevations, plans and sections to each other in making mechanical drawings.

The writer is a practical mechanic and not a professional picture maker, and one who has had over a quarter of a century's experience in designing and delineating mechanical objects, combinations and machines of different kinds, coupled with the experience of following up the above-named drawings through the pattern shop, foundry, machine and blacksmith shop until completed, set up, and operated. He desires to place before his fellow workmen, through your columns, his views upon the above subject.

It is the practice of most practical men, as also it is the writer's, to place the different views of the object delineated in the most convenient positions, regardless of any conventional rule whatsoever. Under this usage I have yet to discover the first inconvenience or complaint arising therefrom. It will be understood, as a matter of course, that a proper and distinctive title be placed over or upon each and every view upon the drawing, indicating that it is an elevation, section, or plan, also stating from what point the view was taken, and where the section was cut from. These would indicate at a glance and convey to the mind clearly, irrespective of their position on the paper, just what the designer wished constructed, and that is all that I understand a mechanical drawing to be for, and therefore any method that will meet this end fills the bill.

Another point in which some practical men err, is in supposing that a plan is merely the outline of the ground or space upon which an object stands, whereas it includes all that may project beyond this, or overhang the base, or in other words, a plan is what the eye can see when looking straight down upon an object. "*It must be remembered that in projection the visual rays are supposed to be parallel to each other, and not convergent, as in perspective.*"—*Davidson.*

An object, if turned at right angles to its former position, the elevation now will be what was in the former position the plan, and the plan will be the elevation. In the drawing of details, any side may be used to represent plan or elevation, to suit the desire of the draughtsman.

A good many draughtsmen oppose the plan of shading drawings, for no good reason that I could ever find out. It is my practice to shade nearly all I do, thus showing in a graphic manner the different shapes and forms at a glance, much better and more pleasing to the eye than would be a flat outline drawing. My practice is after inking in the outlines and cleaning the drawing, to use a crayon and pencil to shade with, and to tone down with a stump, which is a piece of chamois leather twisted up and used as a rubber. I enclose you a simple specimen which will explain itself. A child can tell by it just exactly what shape each section is intended to represent, and compared with the same figure underneath, in outline merely, there is no comparison, as the accompanying drawing will plainly show.

By a little careful manipulation these shaded drawings are successfully varnished with the ordinary yellow shellac varnish used by pattern makers, thus preserving them and making them so they can be washed and kept clean.

For detail drawings, I would follow the plan of your inimitable writer Chordal, as stated by him in one of his letters a short time ago, as published in your columns.

I may, in a future paper, say something of isometric and other perspective drawings which may be used with advantage in the workshop.

Yours truly,

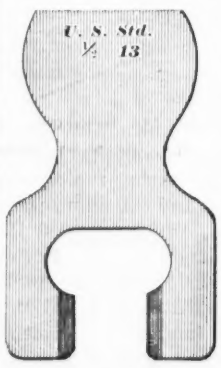
T-SQUARE.

Pittsburg, Nov. 1st, 1880.

A GAUGE FOR TAPS AND SCREWS.

Editor American Machinist:

Being a reader of the AMERICAN MACHINIST, and a lover of anything that has a tendency to promote "mechanical refinement," I take pleasure in giving to the mechanical world what our boys call the cheapest, greatest and most accurate time-saving gauge for taps and screws they ever saw.



Side View

End View

If it is old to any, it is new to me, for I was driven to its invention by finding no taps in the market as well suited to our work as those we could make, if we could get them uniform in size. A solid gauge is not reliable, because the small chips are liable to get into the threads, and the time wasted in cutting and trying makes it an expensive one. Every tool maker knows the strain put upon his conscience when he tries to account for missfits in interchangeable work.

The sketch herewith is intended to show a full size gauge for ½" made from saw steel about $\frac{3}{32}$" thick, with one side offset to suit lead of thread, and fitted with file, scraper and red lead to a tap, the size of which is kept for standard. Then the sharp edge is taken off with a fine file, after which the bearing points are heated in melted lead and cooled in oil.

Very respectfully,

Canton, O. CARBON.

ON THE "BELT QUESTION."

Editor American Machinist:

It is bad economy to use a narrow belt for any purpose, for the reason that a narrow belt requires to be stretched so tight to do its work that it soon gives out; and in addition, by reason of its tension, it is hard upon the journals of the machine which is driven by it. Knowing the above to be true, the writer has very often put belts upon machines that were too narrow to do the work that was required of them, and the remedy in each case was to get wider belts, resulting in greater durability of belts and machinery, and the performance of more work thereby. This has happened so often with the same result, and with no other changes being made, that I am confirmed in the opinion—Haswell and others to the contrary, notwithstanding—that the width of a belt has a great deal to do with its pulling power.

"B."

Mr. Adamson, at a meeting of the British Iron and Steel Institute, at Dusseldorf, strongly condemned the practice of endeavoring to strengthen steel by tempering it in oil, because while that practice might increase the tensile strength, it impaired the elasticity and ductility of the metal.

There are in Philadelphia 103 iron factories employing 12,000 men, not including those employed at the Baldwin Locomotive Works.

Allentown, Pa., has already subscribed $61,000 toward the erection of silk mills in that city.

The manufacturing statistics of Louisville, Ky., prepared for the census, show that in ten years Louisville's manufacturing interests have more than doubled in capacity. The manufacturers of Louisville employ 16,451 hands in 1191 establishments. These establishments represent a capital of $20,364,449; distribute $5,765,387 annually in wages; consume material costing $22,362,704; and produce goods valued at $35,908,338.

Detroit, Mich. has 820 manufacturing establishments, employing $13,226,373 capital and 17,870 persons, and producing $22,161,372 worth of goods. If the Michigan car works and other industries just beyond the limits were included, however, the yearly product would be swollen to nearly $30,000,000.

An impression prevails among some mechanics that chilled iron cannot be turned in a lathe, as other metal can, but this is erroneous; with proper appliances chilled is as easily turned as soft as iron. Slow speeds and wide-faced tools, like those used for turning brass, are employed with satisfactory results. All chilled rolls used in paper-making machinery, and in metal rolling, are turned before being ground.

Thus far during 1880, the North Chicago Rolling Mill Co. have employed constantly 4,780 workmen.

Dessiccated potatoes, pressed to a small compass have been experimented on by California parties, and a shipment to England last year was very profitable, and the operation is now to be carried on on a much larger scale.

Putting a New Crank Pin in the Engines of the Steamer Knickerbocker.

BY LEWIS JOHNSON.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

In the month of March, 1876, I was called upon to put a new pin in the cranks of the steamer "Knickerbocker," belonging to the Cromwell Line of steamers, plying between New York and New Orleans. This steamer, under command of Capt. Frank Kemble, had left her wharf at New Orleans on the regular sailing day, and had proceeded so far on her voyage to New York as to have reached a distance of 100 miles from the mouths of the Mississippi river. At this time, it was discovered that the crank pin had broken entirely in two, the fracture occurring inside of the forward crank eye, about one inch distant from the inside face of the crank. After consultation by the officers in charge, it was determined to take the vessel back to New Orleans, as it was deemed unsafe to proceed on the voyage homeward. The vessel was headed back to New Orleans under moderate speed, and it was found that while the engine was driven ahead, the inch of solid pin projecting into the eye of the forward crank carried the crank around with security. The steamer reached her wharf under steam safely, requiring the assistance of a tug in effecting a landing only.

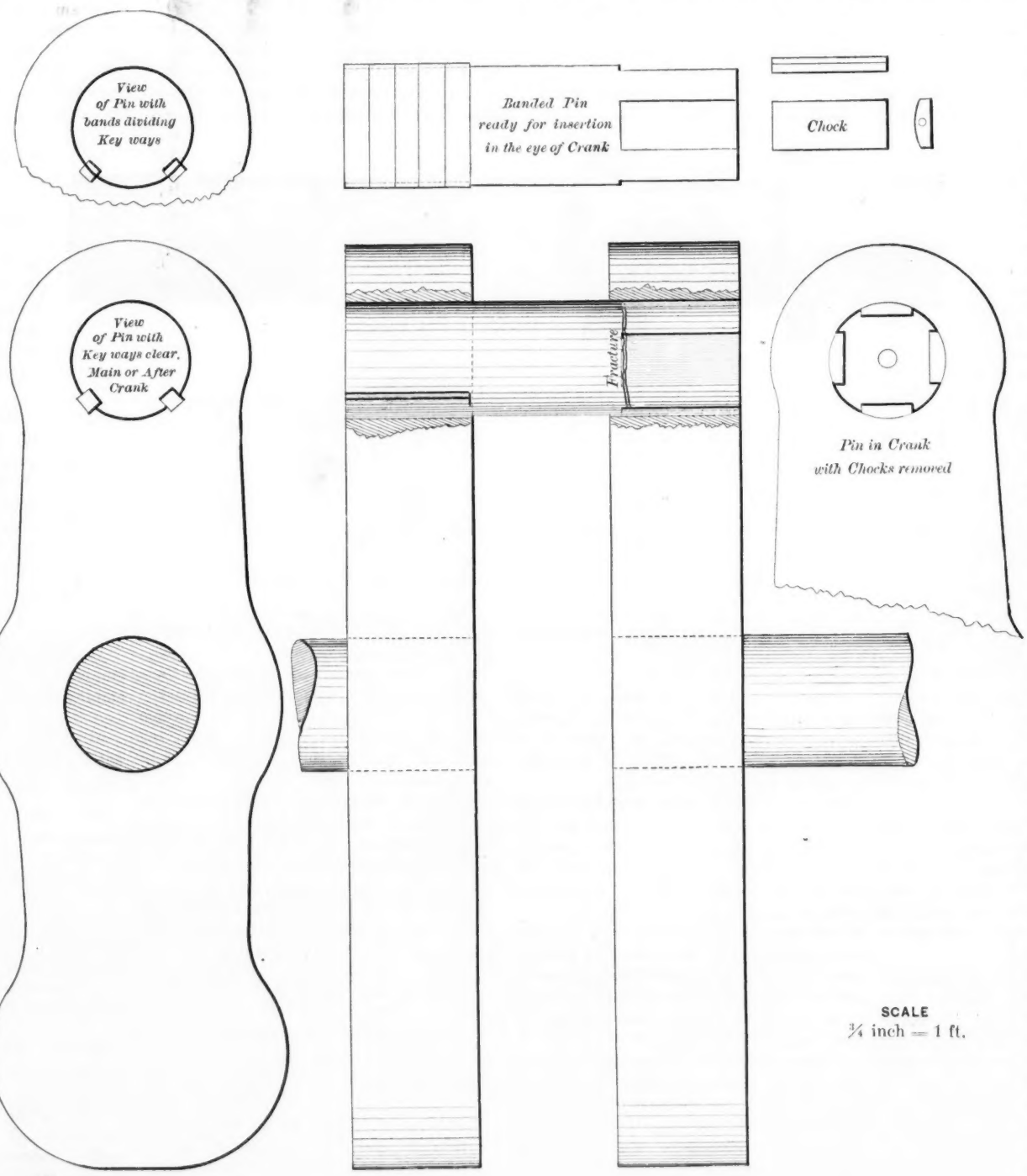
A brief description of the cranks and pin will give a clearer conception of the job in store for me. The cranks were of wrought iron of the balanced type, each crank fast to its respective shaft, and the pin permanently fast in the after or main crank only. In the eye of the forward or drag crank, the pin was secured by means of chocks or keys, in a manner familiar to marine engineers, and shown in the accompanying drawing. The pin was of 12 inches diameter, its length between the cranks 14 inches, and the thickness of cranks each 13 inches, making the entire length of the pin 40 inches. I may err in some of the dimensions, as I am trusting entirely to memory in the matter, but the dimensions do not materially affect the purpose of this paper which is merely to describe the operation of taking out the old pin and inserting the new, an operation which presented some peculiarities of probable interest to mechanical engineers.

The first step taken toward repairing the disabled machinery was the removal of the old pin. An effort was made to dislodge the chocks in the forward crank eye by driving, but with so little success that in view of the necessity of getting the vessel to sea again with as little delay as possible, I determined to resort to a process of heating and shrinking which had beforetime been practiced on a smaller scale by myself and others. Preparations were immediately made for heating the crank ends alternately, beginning with the forward crank, that holding the chocks. The cranks were placed in a horizontal position, with the pin on the port side. A basket or crate of iron plate was erected under the crank end for the purpose of holding the fire for heating. The body of the crank and the surrounding portions of the frame and engine were protected from the heat by plates of iron erected and secured by wire. A fire of charcoal was then started and fanned to a glow by means of hand bellows, kept in operation by relay of hands for about six hours. During the process of heating the crank end, all that portion of the crank as well as the surrounding parts of engine which might have been injured by heat were kept cool by a stream of water directed through ordinary hose.

At the expiration of the time above-mentioned, the coal was removed and fire extinguished. The crown of the crank surrounding the pin was found visibly red, this symptom of heat rapidly losing itself toward the center of the crank. The stream of water was now turned on the heated crank eye, shrinking occurring rapidly on the outside of the metal and extending gradually toward the pin, which retained its heat the longest. At a certain stage in the process of cooling, the shrinkage of the crank eye on the pin could be distinctly heard, the sound conveying the impression of some hard substance being crushed in the jaws of a powerful vise. The water was turned off after the metal had become comfortably cool, and an examination of the chocks and broken section of pin followed. These were found perfectly loose and were easily removed by hand. The after crank with its section of pin was next subjected to the treatment that the sister crank had just passed through, with like gratifying results, the section of pin being removed without difficulty. It was noticeable, during the process of cooling the cranks, that when the hose nozzle was directed to one end of the pin the water would flow easily through the eye around the pin. Of course this occurred after the metal had become somewhat cool.

A measurement of the pin and the eye of the crank, after the removal of the pin, showed that the eye had been slightly increased in diameter, while the pin had been compressed; the standard of measurement being the body of the pin near the face of the crank, where the crank-pin boxes had effected little or no wear, and assuming the pin to have been of uniform diameter. This assumption was justified by an examination of the spare pin on board, provided for an emergency of this kind. This spare pin had been made of the same dimensions as the fractured pin, and on trial was found too small in diameter for a proper and safe fit in the now expanded eye of the after crank.

If the old pin had been drilled out, the new pin would doubtless have been of the proper size. A difficulty was here presented, that at first gave some uneasiness. It will be remembered, that the object in taking out the old pin in the manner described, was with the view of saving time; and the probabilities were that we had defeated the very object of our desires, in pursuing the plan adopted for removing the pin. I dare not entertain the idea of making an entire new pin, as the delay involved would have been provoking, as well as expensive. A little reflection, however, suggested a way out of the difficulty, which was forthwith adopted. I concluded to turn down that portion of the new pin hugged by the eye of the after crank, to a diameter of $11\frac{3}{4}$ inches, or $\frac{1}{4}$ inch less than the body of the pin, thus making the actual difference of diameters between the crank eye and pin a trifle more than $\frac{1}{4}$ inch. The length of pin thus reduced was 13 inches (the thickness of crank), and this length embraced the two fore and aft key seats already in the pin, and which corresponded in location to those in the crank eye. Coincident with the turning of the pin, I had five welded bands forged, of iron, $\frac{1}{4}$ inch thick, and $2\frac{1}{4}$ inches wide; each of these was bored out to a diameter $\frac{1}{64}$ scant, less than the new diameter of the pin, and the edges faced to a proper width. When the pin had been turned to this new diameter, the bands were ready for use. One of the bands was then heated in a clean coke furnace near by, the pin removed from the centers of the lathe, turned up on end, and the hot band dropped on the pin up to the shoulder left by the turning; after cooling the band the pin was again placed between centres, and a rough cut taken off the outer surface of the band; each of the remaining bands was placed on the pin and turned off—successively in like manner—and when all the bands were on, a final cut was taken off leaving the pin with a new diameter, a scant $\frac{1}{64}$ larger than the eye of the crank. The precaution of turning off the bands successively as described, was rendered necessary to insure the safety of the bands from bursting by the shrinking strain, either in the weld or elsewhere in taking off the final cut, for had any of the inside bands yielded to the strain, it is clear, that the bands following would have to be removed to put on a new band, and if the first band had broken the whole operation of banding would have to be repeated, a loss of time we could not afford to risk. I was fortunate in not having any of the bands break. The pin was now ready for inserting in the crank. The after crank was then heated in the usual way to a red heat in the crown, and without the least difficulty the pin was inserted and adjusted to bring the key ways fair, the whole operation being performed without excitement and only in moderate haste. The crank was then gradually cooled with the hose, and when cooled and the debris removed, the divisions of key ways made by the bands (shown in the drawing) were cut away by sharp side chisels, the sides of key ways dressed, the new keys fitted and driven at this end of the pin, the chocks fitted and driven at the other end, the safety plate fastened over the ends of chocks, and the job was completed. This same pin is still in the cranks of the vessel, and apparently as sound and serviceable as the day it was put in. The actual time consumed in performing the job was something less than five days, working continuously day and night.


View of Pin with bands dividing Key ways
Banded Pin ready for insertion in the eye of Crank
Chock
View of Pin with Key ways clear. Main or After Crank
Fracture
Pin in Crank with Chocks removed
SCALE
¾ inch = 1 ft.

It is proper here to remark that I was indebted for valuable support and assistance to Mr. Geo. H. Clarke, the chief engineer of the steamship Knickerbocker, and his able assistants.

The revenue of our railroads last year was about double that of the U. S. Government.

Apprentice Papers.

BY CHORDAL.

VI.—INERTIA AND FORCE.

If a block of iron be laid upon a table it will not move of its own accord. This iron, or any quantity of iron, may be worked up into cannon balls, or locomotives, or railroad cars, or wheelbarrows, or boilers, or steam engines, or arrows, or clocks, or wheel gearing, or machinery or anything else, and it will never show the least tendency to move of its own accord. What we say of iron we may say of everything else; everything on earth; every particle of matter in the universe.

There is nothing in matter which in any degree gives it any tendency to move. This indisposition of matter to set itself in motion is termed *Inertia*. We say that all matter is *Inert*. When matter moves, in any way whatever, something moves it; it never moves itself. Anything which acts on matter, so as to cause motion, is termed *Force*. It is impossible to say what force is. It is one of nature's mysteries of which we know little or nothing.

But we may study the action of the most mysterious things, and thus acquaint ourselves with the laws and principles of those actions. In this way man may make excellent uses of things which he does not understand.

Force is one of the mysteries of nature which we can command and apply in thousands of ways, and the laws of force are so well understood that we can work intelligently.

While force acts in many different ways, we find after all that it is simply one thing, and that is a capacity to put matter in motion.

There are forces which are always in action or always wanting to act. Thus gravity is a force constantly tending to move things toward the earth's center. If we lay a block of iron on a table, the force of gravity tends to pull the block to the earth. The block has no tendency to move downward of its own accord. It is inert. But if we pull the table out from under the block the block moves to the earth. The amount of the force depends on the mass of the block. Even when the table is under the block the force of gravity is drawing the block downward, and if the mass is great the table may break under the strain imposed by the force of gravity. We would generally say that the block of iron broke the table down, but in fact it is the force of gravity acting on the block which breaks the table.

When we speak of the *weight* of a thing, we refer to the amount of force which gravity exerts on that thing, and, as stated some time back, the amount of this action, and consequently the weight of a thing, depends on the amount of matter in that thing. Thus one ball of iron may be drawn downward with a certain degree of force. Two balls of the same size will be drawn downward with twice that force, and we say two balls weigh twice as much as one ball. If we could squeeze and compress two balls hard enough to get them into the size of one ball there would be as much matter in the one dense ball as there was in the two balls, and the one dense ball would weigh as much as the two balls did before.

When a force is acting on something and still no motion of that thing is produced, it is because the force meets with a *resistance*. Thus, when the block of iron is on the table, the force of gravity is trying to pull the block to the earth, and still the block does not move. It does not move because the force of gravity meets with a resistance. The supporting table in this case is the resistance. The resistance in this case is as great as the force. If the table breaks down, it shows that the resistance was not as great as the force. Gravity can only produce motion when it can pull something from a higher place to a lower place.

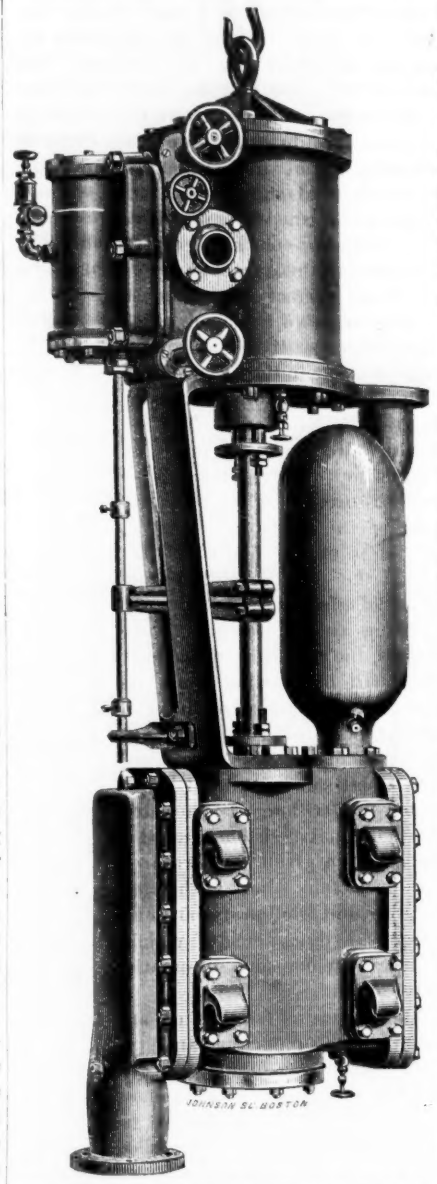
If we want to move a block of iron from the ground to the table, we apply the force of our muscles and lift it. In this case our muscles yield, the force and gravity become a resistance. Our muscles tend to lift the block, and gravity tends to hold it down.

If we are able to lift the block, it is because we apply a force sufficient to overcome the resistance. If we cannot lift the block, it is because we cannot apply a force as great as the resistance. Let it be distinctly understood that the block does not tend to lift itself up or to move itself downward. Matter is inert, and the motion results from the application of force to matter. It will thus be seen that there is nothing in a machine of any kind which will cause it to move. Force must be applied. No steam engine moves itself; the boiler of an engine does not move the engine; the water in the boiler does not move the engine. All this is simply matter, perfectly inert, and without any power to move. If we want an engine to move we apply the expansive power of *heat* to the water, and the expansion of the water into steam gives us a convenient plan for causing the heat force to move the engine. No water wheel runs itself. Gravity pulls water downward, and we find a waterwheel a convenient device for getting us rotary motion from the force of gravity. No watch or clock will run itself. It is inert matter. We apply muscular force to a watch key and wind a spring, the spring is elastic and tends to unwind with about the same amount of force it took to wind it. This unwinding runs the watch. The spring has no power. It is inert and only gives out power which is put into it. It is thus seen that watches and clocks run by muscle power.

At this point it will be interesting to trace the source of some of our common forces.

New Pumping Engines for Mining.

In pumping water from very deep mines, where large bodies of water are to be raised on heavy lifts, it has been found that the ordinary pumps are not adapted to that kind of work.

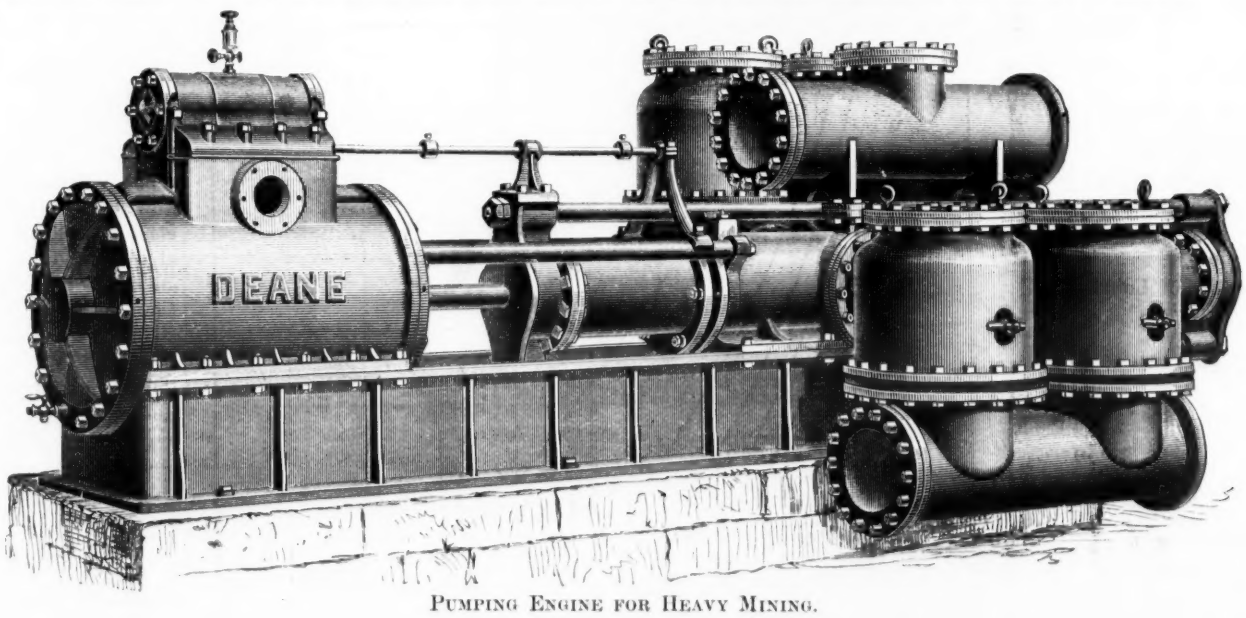


SINKING PUMP FOR SHAFTS AND WELLS.

The pump here represented has a 30 inch steam cylinder, 14 inch plungers and a stroke of 36 inches. It is now in operation at the bottom of a shaft 350 feet deep, and is said to work entirely satisfactory.

The pump represented by the upper engraving shown herewith, is also made by the same company, and is designed for recovering shafts and for working in a contracted space. It can either be attached to timbers for raising and lowering in the shaft or may be suspended by means of the ring in the top cylinder head. These machines are furnished with air chambers and the pumps with or without removable linings as desired. The steam cylinders are provided with valves for regulating the speed and stroke. The parts are simple in construction, and may be quickly removed for inspection or repairs.

The dimensions of the pump here shown, is as follows: steam cylinder 14 inches, and water cylinder 7 inches, with a stroke of 16 inches. The parts of these pumps are made interchangeable by means of U. S. Standard gauges and templates.



PUMPING ENGINE FOR HEAVY MINING.

The Deane Steam Pump Co., of Holyoke, Mass., (Warerooms 92 and 94 Liberty St., New York), have built a pump designed particularly for heavy work, which is represented in the accompanying engraving. The general construction will be readily understood by an engineer, who will perceive that the valves and all parts likely to require more than ordinary attention, are easily accessible. The engine is of the same style as that used upon the regular Deane Pump. These pumps are arranged for using high pressure steam, with a condenser or open exhaust, and when desired, they are provided with compound condensing engines, which are preferred in localities where fuel is expensive.

Mechanical Correctness.

BY CHARLES A. HAGUE.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

Mechanical correctness is the adaptation of the proper means to the accomplishment of the ends in view, hence the success of mechanical engineers must necessarily depend upon the extent to which they satisfy the conditions governing the production of the effect sought.

Throughout the long list of industries calling for the services of engineers, the characters of the different operations constantly change to suit the varying demands.

Correctness of manipulation in machine construction does not always mean extreme closeness of fit. The automatic cut-off gear of steam engines, for example, requires to be sufficiently sensitive, to enable it to adjust itself at the slightest attempt to fluctuate in the speed of the balance wheel. This action should resemble as near as possible the operation of the human will controlling the muscles through the medium of the nerves.

A tolerably clear conception of the action necessary to regulate speed, under varying demands for energy, may be obtained by attempting to walk at a perfectly uniform rate of speed against a very strong but unsteady wind; the muscular exertions under such conditions would constantly vary in intensity, to meet the fluctuations in pressure of the gusts of wind against the body.

The principal obstacles to close regulation in steam engines are friction and lost motion of the regulating gear; friction, of course, being the greater, because upon the efforts of the friction depend the extent to which lost motion is realized.

In some of the best types of automatic engines the controlling mechanism is fitted up with a looseness of joints that would be entirely out of place in the slide rest of a lathe, or in the equally important parts of other machine tools. But this looseness of fit in the engine gear is the guarantee of precise automatic action; each part should be so disposed as to come squarely and, above all, promptly to its work, the different relative positions corresponding to the different points of cut off being the important items.

The attempt at uniformity of speed is sometimes defeated by reason of an unnecessary, though well-intended, closeness of workmanship, by means of which the "nerve quality" of the engine is impaired; and the demands, telegraphed from balance wheel to regulator, for more or less energy as the case may be, are not satisfied with sufficient precision.

As an example in which correctness and closeness go hand in hand, your attention is directed to milling and gear-cutting machines.

In this case a moderate amount of friction is not objectionable, the purpose in view being to produce mechanism, in which lost motion shall be avoided to the utmost possible extent consistent with practice.

Required, a spindle that shall revolve without a particle of shake, but still sufficiently free in its bearings to permit of lubrication. The sliding carriage to which the work is secured is so accurately fitted by means of skillful scraping that it may be freely moved on its bearings and still possess qualities of extreme rigidity in a direction at right angles to its line of motion; the surfaces of these bearings approximating so closely to plane surfaces that, were it not for the lubricant interposed between the parts in apparent contact, they could be made to touch each other at all points.

If it were possible to divide an index plate so accurately that its errors were within the thousandth part of a second, the fullest advantage could not be taken of its precision, unless the balance of the operating parts of the machine were of a quality fit to bear it company.

But it may be safely said that the road, at least, to mechanical correctness has been reached in a practical sense, when we consider the fact that machines are even now produced, by means of which a gear of, say, two hundred teeth may be accurately cut without first marking off its circumference.

In following up this path of correctness, it is highly important to understand just what we desire to accomplish; to rightly appreciate the necessities of the case in hand, whatever it may be; and it must be also borne in mind that there is a financial phase to the subject, that there must be an adaptation of commercial as well as mechanical means to suit the ends in view. Under some conditions there will be found justification in comparatively heavy investment in the matter of plant and appliances, while under other conditions the undertaking may be of a nature so limited that a process of a permanent character would be forbidden.

In some classes of machinery, the manufacturers thereof are not brought into intimate contact with their productions with the same degree of interest that their customers are, and, consequently, the progress towards perfection is somewhat dependent upon the criticisms and demands of their patrons; and as these broadcast comments, when brought to a single focus, are very likely to appear to a certain degree contradictory, our manufacturing engineer, unless he possess the faculty of sifting evidence pretty thoroughly, is not unlikely to lose sight of the way to correctness in a metaphysical fog.

To settle a question in one's own mind is not the easiest or most rapid operation known, but when we attempt to dictate to others whose experience has placed them in a position from which things do not appear quite the same as from our own standpoint, the difficulties are immeasurably increased.

It has been said that when two persons are engaged in controversy, there are really six personalities present. First, the pair as they really are; second, the pair as each thinks the other is, and third, the pair as each considers himself. But in view of the fact that a very large number would result from the application of such a course of reasoning to this body of engineers, let us hope that in our progress along the track of mechanical correctness, we may be so directed that we shall be practically a unit.

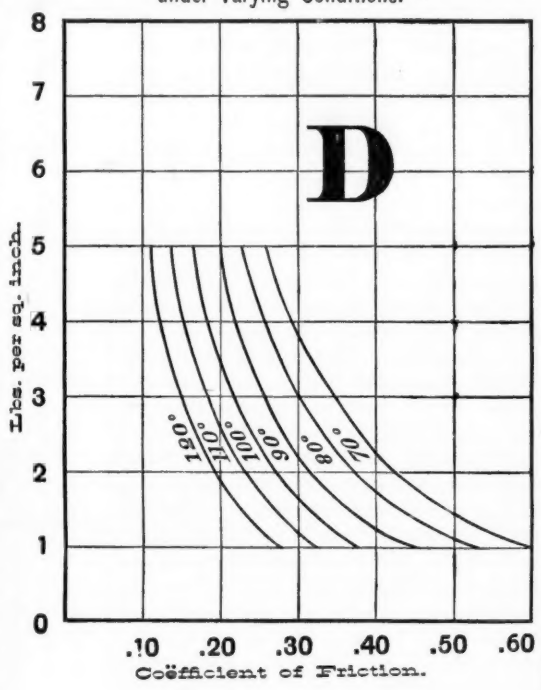
Measurements of the Friction of Lubricating Oils.

By C. J. H. Woodbury, Boston, Mass.

A PAPER READ BEFORE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The resistance existing between bodies of fixed matter, moving with different velocities or directions, presents itself in the form of a passive force which results in the diminution or the destruction of apparent motion. Modern science has demonstrated that this destruction is only apparent, being merely the conversion of the force of the moving body into the oscillation of the resisting obstacle, or into that molecular vibration which is recognized as heat. Direct friction refers to the case where the two bodies are in actual contact, and mediate friction where a film of lubricant is interposed between the surfaces; and it is this which applies to nearly every motion in mechanics where bodies slide upon each other. The coefficient of friction is the relation which the pressure upon moving surfaces bears to resistance. I have devoted some time to the examination of this subject, in the interests of the Mill Mutual Insurance Companies of New England. In this report of my work upon the measurement of friction of lubricating oils, I shall restrict myself to a description of the apparatus designed especially for the purpose, the method of its use, and the results obtained with a number of oils in our market which are used for lubricating spindles. Previous investigation of nine different oil-testing machines used showed that none of them could yield consistent duplicate results in furnishing the coefficient of friction. The operation of these machines, by their failure to obtain correct data, adduced certain negative evidence which established positive conditions as indispensable in the construction of a machine capable of measuring the friction of oils. The following circumstances must be known or preserved constant,—temperature, velocity, pressure, area of the frictional surfaces, thickness of the film of oil between the surfaces, and the mechanical effect of the friction. In addition to the foregoing conditions, the radiation of the heat generated by friction must be reduced to a minimum, and the arrangement of the frictional surfaces must be of such nature that no oil can escape until subjected to attrition. To measure the frictional resistance at the instant of a given temperature, and at a time when both temperature and friction are varying, requires a dynamometer which is instantaneous and automatic in its action.

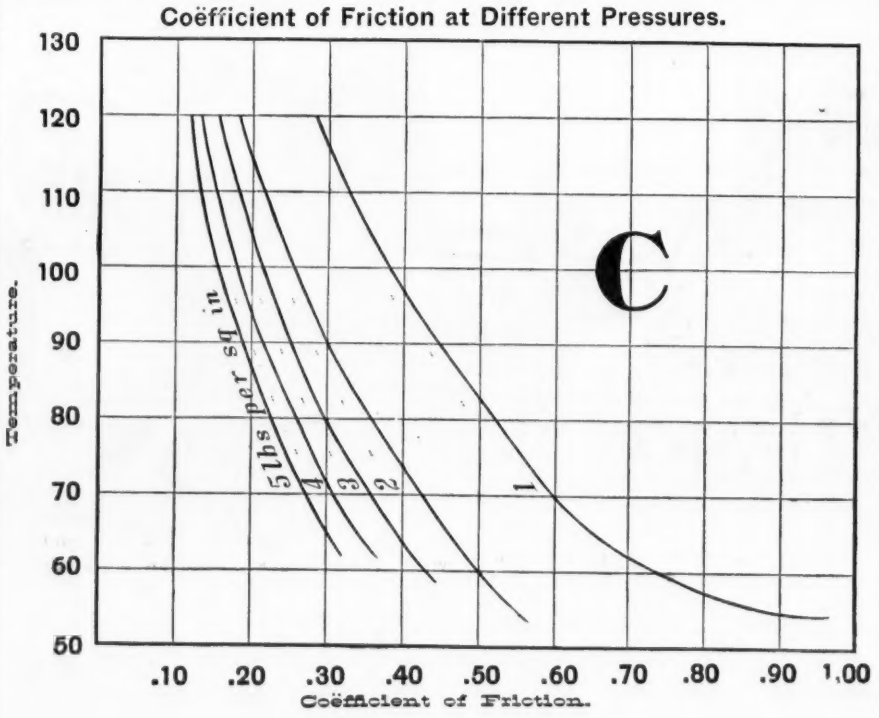
Curves showing Changes of Coëfficient of Friction under Varying Conditions.



The apparatus consists of an iron frame supporting an upright shaft surmounted by an annular disc made of hardened tool steel. Upon the steel disc rests one of hard bronze (composed of the following alloy,—copper 32 parts, lead 2 parts, tin 2 parts, zinc 1 part) in the form of a cylindrical box. Water is fed in at one side and a diaphragm extending nearly across the interior produces a uniform circulation before discharge. Although this use of water is original with the writer in the method of its application, the first use of water to control the temperature of the bearing surfaces of oil-testing machines is due to Monsieur G. Adolphus Hirn, and described by him in a paper on the subject of friction, read before the Société Industrielle de Mulhouse, June 28, 1854. M. Hirn, however, confined his attention chiefly to the determination of the mechanical equivalent of heat, as measured by the amount of heat imparted to the circulating water, expressed in the work of friction. His investigations of lubrication with this apparatus were confined to the friction of lard and olive oils, at the light pressure of about one and four-tenths pounds to the square inch. Mr. Chas. N. Waite, of Manchester, N.H., has independently, and I believe originally, made use of water in a friction machine, and has performed good work in the limit of his experiments.

A protection of wool batting and flannel, to guard the discs against loss of heat by radiation, diminishes the escape of heat to about two degrees per hour, which loss is not appreciable when observations are taken within a few seconds' interval. A thin copper tube, closed at the lower end, reaching through the cover, extends to the bottom of the disc; the bulb of a thermometer is inserted in this tube and measures the temperature of the discs; an oil tube runs to the center of the disc, and a glass tube at the upper end indicates the supply and its rate of consumption, and also serves to maintain a uniform head of oil fed to the bearing surfaces. The rubbing surfaces of both discs were made to coincide with the standard surface plates, in the physical laboratory of the Institute of Technology, and their contact with each other is considered perfect.

Coëfficient of Friction at Different Pressures.



After this surface was finished, the bronze disc was treated with bi-chloride of platinum which deposited a thin film of platinum upon the surface. Upon the application of the discs to each other the steel disc rubbed off the platinum from all parts of the surface, showing the perfection of contact. This nicety of construction enables a film of oil of uniform thickness to exist between the surfaces, and the resistances are not vitiated by the collision of projecting portions of the disc with each other. The rounded end of the upper shaft fits into a corresponding depression in the top of the upper disc. This method of connection retains the disc over the proper center, yet it is allowed to sway enough to correct any irregularity of motion caused by imperfection of construction or wear of the lower disc. To obtain the desired condition of pressure, weights are placed directly upon the upper spindle. The axes of the upper and lower spindles do not lie in the same straight line, but are parallel, being about one-eighth of an inch out of line with each other; such construction, giving a discoid motion, prevents the disc from wearing in rings and assists in the uniform distribution of the oil. An arm is keyed through the lower part of the upper spindle and engages with projections upon the upper disc. Upon this arm, which is turned to the arc of a circle, whose development is two and one-half feet, a thin brass wire is wrapped upon this arc and reaches to the dynamometer, so that the tension of the dynamometer is tangential and the leverage is constant for all positions of the upper disc within its range of motion. The dynamometer consists of a simple bar of spring steel fastened at one end, and bent by the pull applied at the other. Its deflection is indicated by a pointer upon a circular dial, the motion of the spring being multiplied about eighty times by a segment and pinion. The whole is enclosed in a steam gauge case.

When completed, the machine was subjected to a long series of tests with the same oil, to determine the accuracy of the results, and the best method of procuring them. The operation of the machine under equal conditions with the same oil gives results which are as closely consistent with each other as could be expected from such physical measurements. As an example, four tests of the Downer Oil Co. Light Spindle (Sample No. 7) at 100° Fah. and on different days gave .1145, .1094, .1118, .1094: mean, .1113. Another example (Sample No. 14) Heavy Spindle Oil, made by the same firm, yielded for a coefficient of friction as the result of five different trials, .1246, .1195, .1297, .1201, .1221; mean, 1233. Much of the irregularity, slight as it is, is due to the variable speed of the engine. Concurrent results were obtained under equal circumstances, but the coefficient of friction varied, not merely with the lubricants used, but also with the temperature, pressure, and velocity. The results of my own experiments on mediate friction do not agree with the laws of friction as given in works on mechanics, but the coefficient of friction varies in an inverse ratio with the pressure, as shown graphically on diagram C.

The variation of friction with the temperature is shown, graphically, on all sheets reporting the friction of each sample of oil. These curves belong to the hyperbolic class of a high degree; but I have not been able to deduce an equation which will answer to the conditions of more than one, because the law of the curves is modified by a constant dependent upon the individual sample of oil used. A little difference in the sample would cause a difference in the line of curve. Reference is made to diagram D, showing the coefficient of friction under equal ranges of temperature and velocity, but with a different series of pressures.

Coefficient of friction at 100° and 500 revolutions per minute:

Pressure per sq. inch.	Coefficient of friction.
1 pound	.3818
2 "	.2686
3 "	.2171
4 "	.1849
5 "	.1743

The ratio of the changing coefficient varies with the temperature at which the range of results is taken.

Friction varies with the area, because the adhesiveness of the lubricant is proportional to the area, and the resistance due to this cause is a larger fraction of the total mechanical effect with light, than it is with heavy pressures.

The limit of pressure permitting free lubrication varies with the conditions; for constant pressures and slow motion it is believed to be about 500 pounds per square inch, while for intermittent pressures, like

the wrist pin of a locomotive, the pressure amounts to 3.000 pounds per square inch. It has been stated that about 4,000 foot pounds of frictional resistance per square inch is the maximum limit of safe friction under ordinary circumstances.

As the results of this preliminary work indicated that the coefficient of friction varied with all the circumstances, it was necessary to simulate the conditions of specific practical applications to determine the value of a lubricant for such purposes.

It was decided to begin these investigations with spindle oils, and therefore the machine was loaded with five pounds to the square inch, and run at about 500 revolutions per minute, as the oil is then submitted to conditions of attrition, corresponding to those met with in extremes of velocity and pressure, in the case of a Sawyer spindle running at 7,600 revolutions per minute with a band tension of four pounds, and the results subsequently given refer only to the friction under these conditions, except when definitely stated to the contrary.

This particular spindle was selected because that of the five million ring spindles in the United States, about one and a half million are of this manufacture, and in a large number of the remainder the conditions of lubrication are quite similar.

In a Sawyer spindle, the step measures three eights by fifteen-hundredths inches, and receives seven-ninths of the pull due to the band. If that tension is four pounds, three and one ninth pounds are transmitted to the step, whose projected area is nine-sixteenth square inches. The pressure per square inch is, therefore, five and one-third (say five) pounds.

The diameter of the spindle at bolster is .28″, or .8976″ in circumference. At 7,600 revolutions per minute, its velocity amounts to 6,685″, or 557 feet, per minute; and the mean area of the discs of the oil machine must revolve at this speed.

To give a desired frictional velocity of 6,685 inches per minute, the discs must revolve at 6,685 divided by 13.45=497 (say 500 revolutions per minute. To recapitulate: By revolving the disc at 500 revolutions per minute, with a pressure of 5 pounds per square inch, the oil is submitted to conditions of attrition, corresponding to those in the extremes of velocity and pressure met with in a Sawyer spindle revolving at 7,600 revolutions with a band tension of 4 pounds.

My reason for giving such a detailed statement is because the value of investigations upon this subject must be measured by the precision with which all the conditions are observed.

The apparatus is used in the following manner to measure the coefficient of friction of oil. After cleaning with gasoline and wiping carefully with wash leather, the discs are oiled and run for about five hours, being kept cool by a stream of water circulating through the upper disc. From time to time they are taken apart, cleaned, and oiled again. After using any oil, even if the discs are afterwards cleaned, the results with the oil subsequently used give the characteristics of the previous oil, and it is only after thirty-five to forty-five miles of attrition that these results become consistent with each other; each succeeding result, meantime, approaching the final series. This seems to indicate that friction exists at the surface of the two discs between the film of oil acting as a washer and the globules of oil partially embedded within the pores of the metal. If the dense bronze and steel retain the oil despite attempts to remove it, how much longer must it require to replace the oil in machinery with a new variety whose merits are to be tested. These experiments confirm the wisdom of the increasing use of cast iron for journals, as its porosity enables it to contain and distribute the lubricant.

When the discs are ready to test the oil the apparatus is cooled by the circulation of water; the flow of which is stopped when the machine is started. At every degree of temperature, the corresponding resistance is read on the dynamometer. When the thermometer indicates a temperature of sixty degrees, the counter is thrown in gear, and the time noted. When one hundred and thirty degrees is reached, the counter is thrown out of gear, and the time noted. This not only gives the velocity of the rubbing surfaces, but the number of revolutions required to raise the temperature a stated number of degrees, and is a close criterion of the oil. The co-efficient of friction is the ratio of the pressure to the resistance.

The following table shows the resistance of friction at 100° 500 revolutions, for various pressures:

RESI-TANCE OF FRICTION AT 100°.

Pressure.	Resistance on Dynamometer.	Equivalent band tension.
1 lb.	2.62 lbs.	0.8
2 "	3.68 "	1.6
3 "	4.48 "	2.4
4 "	5.28 "	3.2
5 "	5.98 "	4.0

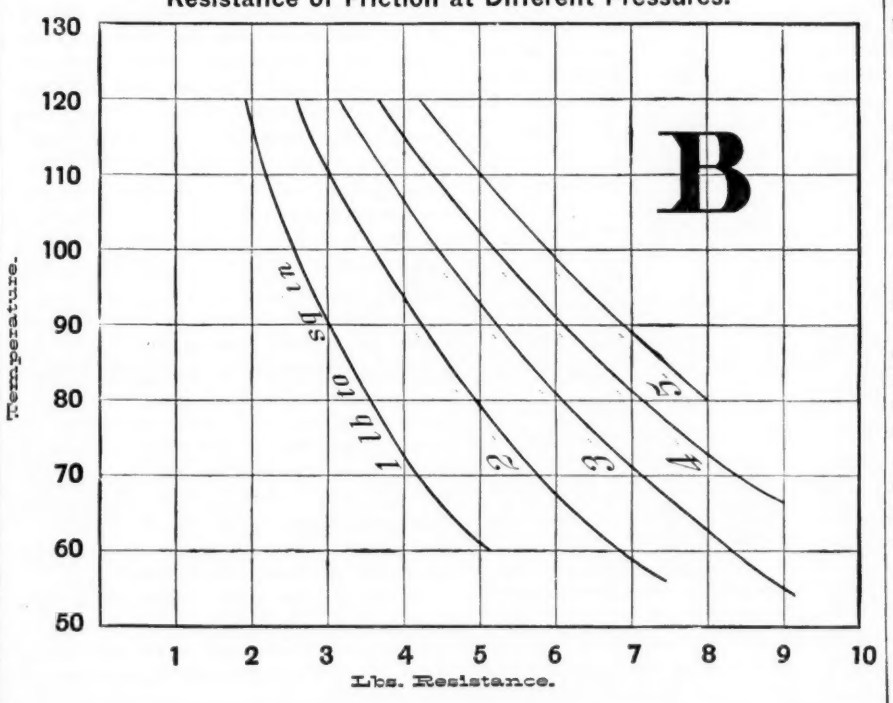
For further detailed results, reference is made to diagram B.

(To be continued in our next.)

Manufacturing Notes.

L. A. & J. J. Jacobs have removed their machine shop and foundry from Mendota, Ill., and located it in Avoca, Pottawattamie County, Iowa. The citizens of the latter place contributed in money to bring about the transfer.

Resistance of Friction at Different Pressures.



The Great Western M'f'g Co., of Leavenworth, Kan., have just completed a new brick machine shop, 150 × 75, three stories in height, and have added a number of new machines.

The Black Diamond File Works, Philadelphia, intend to make an extensive addition to their buildings on Richmond street early in the coming year.

Barrows, Savery & Co., Limited, Philadelphia, shipped lately an invoice of kettles, for use in manufacturing palm soap, to Liberia, Africa, some of which weighed 1,000 pounds.

There are in Philadelphia 103 manufacturing establishments of iron works, employing 12,000 men, not including those employed at the Baldwin Locomotive Works.

A cotton factory, to cost about $350,000, is projected at Jacksonville, Fla. The location has been chosen, and the capitalists interested are at the North selecting machinery and making arrangements to begin work.

There has been shipped to Japan a large quantity of mining machinery, manufactured at the Pacific Iron Works in San Francisco, and consigned to the Japanese government for use in the mines of Japan.

The new foundry at Reno, Nev., was announced to begin work a few days ago.

Ground has been broken at Chester, Pa., for a new cotton mill, which is being erected for Samuel A. Crozer. It will be 60x160 feet.

Keyser & Rix have erected new works at Frankford, Philadelphia, Pa., for the manufacture of novelty hardware.

The Eureka Manufacturing Company, of Rock Falls, Ill., manufacturers of agricultural implements and school furniture, are erecting a three story addition to their works, which will be, when completed, 100 feet in length and about 50 feet wide. This will add largely to their capacity for production.

An axe factory at Lewiston, Pa., is filling an order for double-bitted axes, to go to Brazil for use in felling mahogany trees.

The annual meeting of the Coatesville Iron Co., was held at the Company's offices, on Tuesday Nov. 16th. The following gentlemen were elected directors for the ensuing year: Hon. Andrew Williams, of Plattsburgh; Chas. Wheeler, of Morris, Tasker & Co, Limited, Philadelphia; Geo. Brooke, of Birdsboro, Pa.; W. J. Carmichael, of New York, and W. P. Worth, of Coatesville, Pa. Mr. Williams was re-elected President and Mr. Carmichael re-elected Treasurer. The company is well supplied with good orders, and purpose building three additional furnaces to increase their capacity.

A correspondent from Minneapolis, Minn., sends us the following:

The firm of Douglass & Hall, Machinists, have dissolved—Mr. Douglass retiring and Mr. Hall continuing the business.

Union Iron Works, Lockwood & Co., are full of orders.

Our ex-Governor Washburn, owner of the largest flour mill in the world (capacity 3,000 barrels of flour a day), has come down to leveling railroad tracks. How he could find time to devote to any other matter than his big mill is a wonder to all, but a visit will soon convince one that the big mill nearly runs itself. Everything goes like clockwork, and is kept so. All the latest labor-saving contrivances to be found are in the mill.

Variety Iron Works, Hashen, Maish & Davis, will move into their new machine shop about the 20th of November. The owners, being all practical mechanics, have constructed the building for their wants, and they have one of the best shops in the Northwest, well lighted and ventilated, everything first-class. They have their boiler set on the Butman system.

The Watrous Engine Works Company, Brantford, Ont., are extending their premises.

The Fisk Manufacturing Co., Springfield, Mass., has been incorporated with George C. Fisk, Prest.; Noyes W. Fisk, Treas. Capital, $50,000, in shares of $100 each. For the manufacture and sale of soap, candles and other articles of a like nature..

The American Net and Twine Co, Boston, Mass., has been incorporated, with William Stowe, President, and John W. Fairbanks, Treasurer. Capital, $300,000. in shares of $100 each. For the manufacture and sale of twine, nets, seines, lines and fishing material.

Our readers are aware that most of the fuel for manufacturing and steam purposes used abroad—especially in England, is bituminous, but veins of anthracite exist there, notably in Monmouthshire, South Wales, and have been worked for many years; but, so great is the hold that habit and common custom obtain among British manufacturers, it is not regarded with favor in spite of its palpable advantages in cleanliness, heating power and kindred qualities.

The Welsh anthracite is remarkably good, from the analysis made of it, showing 94 per cent. of carbon with a trace (.59) of sulphur, and about one per cent. of ash. Dr. Percy argues as against its introduction that it *may* decrepitate, or break up into small pieces, and thus clog the fire; it does not seem to have occurred to him that if it did the small pieces would burn as well as the rest.

The Pittsburgh Telegraph says: The impossibility of filling present orders at American mills is sending the bulk of orders for steel rails to England. At present prices, this description, as well as iron, can be imported at smaller cost than they can be bought here.

The intention of Mr. Jay Gould and his associates to secure a new connection for the Union Pacific road with the Pacific coast, some time ago referred to, is now, it is stated, about to be put in force. A third rail is to be laid on the Utah & Northern narrow gauge road from Ogden northward, forty miles, from whence a standard gauge road is to be built, within eighteen months, to Boise City, Idaho, about 250 miles from Ogden. This will leave a gap of only about 100 miles to Baker City, Oregon, the point to which the Oregon Railway & Navigation Co.'s line is to be extended about the same time, and the completion of another transcontinental line by building this missing link evidently will not long be delayed.—*Railway Age.*

The Farmer's Dependence on Machinery.

Following is an extract from a well-thought article in *Capital and Labor* of London:

The mechanical power of the age is like a series of concentric and eccentric circles; of which the farmer stands out in the principal center. These all revolve with and about agriculture, and the same force sets all in motion. It is the farmer's duty now to make the most of his opportunities. He should be the foremost man of the age. His influence should be felt everywhere. It is felt everywhere, for the wealthiest merchants and capitalists, and the most active politicians, all ask themselves how far the farmers can be depended upon before they make a movement in their special pursuits. But the farmer should feel this himself. It is one thing to have power, and another thing to be cognizant of its possession. Let the farmers consider now their position, and as they take a view of it, let them consider what they owe to the power and influence of machinery. One most conspicuous example of the results pointed out may be noted. A few years ago Minnesota spring wheat was graded very low in the grain markets and brought a low price. Unfortunately for the Western farmers, this grade of spring wheat was the only one they could produce. A new process in milling was introduced. Elaborate machinery was invented to perfect the process. The best wheat by this process was the grade known as "Minnesota Spring," theretofore despised and rejected—literally "rejected," in fact, in the markets. Afterward this grade became sought by millers, and the value advanced to a point equal to and sometimes more than that of the previously much-sought winter wheats. If Minnesota farmers produce forty million bushels of wheat annually, this advanced value, due to the new process, puts several millions of dollars yearly into their pockets; and what a vast amount of comfort and happiness may be secured by the right use of so much money! This is but one instance of the vast concatenation of circumstances which points out the moral here alluded to.

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Old School and New School Machinists.

Thirty years ago, when a boy was apprenticed to the machine business, this was about the order of his initiation:

First year.—Hold a lamp where any man wanted him to, run of errands, sweep the shop, skylark a good deal, and cut bolts with a stock and dies, also take the blame of spoiled work, if he held the lamp so the workman couldn't see.

Second year.—Mash his thumb joint on left hand learning to chip, and break his back with a sixteen-inch file.

Third year.—Spoil work on a lathe occasionally, run the beds of planers off on the floor, and pretend that he knew as much as the foreman, or old hands fifty years at the trade.

Fourth year.—So much advanced in learning his trade, that he would give advice to his foreman, and his opinion as to how work should be done.

Fifth year.—He would begin to doubt whether he knew so much after all. During the sixth and seventh years, being certain of his ignorance, he would set to work like a man and get solid chunks of experience.

During all these years of his novitiate, he would be learning something in spite of himself. He would run this tool, then that; he would work without tools; he would use make-shifts and contrivances, not very well, perhaps, but he would make them answer for the end desired. He would be taken off the lathe and put at the bench, then off the bench to the planer. He wasn't a lathe hand, or a vise hand, or a planer hand, but he was all kinds of a hand. He could do work on one tool as well as another, and, in short with his varied experience, he was a machinist. There were not many planers in those days, so that he had to chip and file a great deal, and he was rather proud of his efficiency in this respect, for, at his best, he could do nearly as quick and as good work as a machine, but he could not keep it up so long.

Where is this man, or his compeers, now? He is out of vogue; his chipping is not wanted, nor much of his filing either. The milling machine beats his fitting out of sight, and all of his various rigs and make-shifts; his chucks made out of wooden blocks, and his straps and clamps on his planers are supplanted by special machines and tools made for the purpose. For his manual dexterity, no shop needs him. New ways of manipulating metals, and tools for it, have laid him on the shelf. System and contracting have taken his mechanical life. He could not make a sewing machine, with his old appliances, for forty prices, as they are now sold. A boy of twenty, on a special machine, will make more set screws than he could on a common lathe or on a bolt cutter. Even his own kit of tools, calipers, surface gauge, twisted scriber, squares, etc., are all made for him cheaper, and, on the whole, better, than he could make them. The supply shops are full of drills, and reamers, and taps, and dies. There is hardly a detail of the machine shop that cannot be bought as needed. Of what use, then, is the old-fashioned machinist, if his trade knowledge is unavailable? He is useful for his experience and knowledge of ways and means. His is skilled labor, in its best sense; he is not beholden to the machine, it is subservient to him. The machine is not sentient, but only obeys the impulse given it, and here is where the experience of years is valuable. Such men are needed to-day, but they are scarce. The sewing machine shops have destroyed them. The pistol factories have bred up another class in their stead, and all shops wherein a quantity of machines of one kind are to be made, have instituted a system of machine work which requires no skilled labor and but a limited experience to operate it. And the tendency is to increase this system of manufacturing machinery or tools. Enormous sums are spent in constructing appliances and apparatus, which, when set in motion, duplicate parts with a rapidity and certainty that no hand work can approach. What are we going to do about it? Must we turn out specialists as machinists, who understand the milling machine and all its belongings thoroughly, but no other branch of the business—who can neither forge, grind, plane, chip, file, nor fit, without a jig or a gauge—who have no manual dexterity whatever, who know nothing of the speed of belts, or power they transmit, to whom the general principles of shop practice are wholly unknown; or shall we insist that before a man is put upon a milling machine, he must serve a regular apprenticeship? That is the question. Again, where shall he serve it? Contractors are not making machinists of the future; they are looking out for themselves. All the gun and pistol shops, all the mower and reaper shops, all the sewing machine shops, and large concerns, where work of varied character is performed, adopt essentially the contract system, so that it is a question where we shall turn for versatile mechanics, who have been bred to the trade they profess, and are capable of instructing others.

A Disputed Point.

A manufacturer who was recently taken to task for employing a very low-grade man as an engineer, responded that he had tried both kinds, high grade and low grade, and that for his purpose—getting the most power in a given time—a man who did not know too much was the most valuable. He justified his position by citing the following example: When an intelligent man, who knew his business, discovered anything out of order about the engine or shop tools, he gave no one any rest until the matter was set right; whereas the unintelligent man never stopped his engine or the tools unless he was ordered to, but kept everything going until it fell down from sheer inability to hold together.

Another manufacturer of bolts said the same thing as to men on bolt-cutting machines: he preferred to hire a man who did not know the dies from the oil can technically, averring that the work was mere routine, and that a mechanic who knew what work the dies should do, was the poorest man he could hire, for he was constantly tinkering at the dies, or the taps, or the chuck, or something, reducing thereby the working capacity of the machine.

There is something to consider in these views, for in some aspects they are true. A good machinist may have the fault of fussing and tinkering with his tools, but that does not prove that his other trade qualifications are valueless. It lies with the employer himself to discover and apply the best qualities of his men, and eradicate their faults for his own advantage. To say that an ignorant man is better on a bolt cutter than an intelligent one is taking a false position; for, from the same standpoint, it would be profitable to dispense with trained men in all branches. To say, broadly, that mere automatic motion—shifting this lever and then that—is more valuable than the superintendence of a regular mechanic is, to our thinking, an opinion based upon superficial observation and not warranted by the facts; and we think the majority of manufacturers, as a matter of choice, take the best and most intelligent men they can get.

Marine Engine Shops in New York City.

The difference between the great machine factories of the Eastern States and some in New York City, where marine engine work is done, is so marked to the experienced observer as to excite wonder, not only at the means employed to secure ends, but in the animus of men in the two sections. From whatever cause it arises, Eastern mechanics seem to have a personal interest in the matter in hand, and work right on without reference to "bell time" or any other time; but in this section, in some shops at least, the men seem to have more or less leisure, which they utilize by conversing with their fellows. Coming suddenly around the corner of a large lathe or planer, it is not unusual to find men who evidently have nothing to bring them there, lounging in a listless attitude or gossiping upon trivial things. They keep a lookout for the foreman or any one from the office; but as for doing all they can for the proprietors—that seems furthermost from their thoughts. Machine tools seem to catch the infection of this example also, for they, too, have periods of inactivity, remaining idle for a long time while the workmen who should be at them are somewhere else. The floors of the shops here are cumbered with work in all stages of progress; with broken parts of engines brought in to be repaired, and with tools out of use left where they were when done with, and the general aspect of matters is such as to cause wonder as to where the profits come from. That this is not inevitable from the character of the work is shown by the appearance of Eastern shops in the same business, and we are forced to the conclusion that order and system are considered of slight importance in conducting some marine engine shops in New York. It is like visiting a political institution to go through one of these shops, wherein the problem is to get the largest number of men for the least amount of work. The slow click of the ratchet drill is heard on every side on jobs that could be drilled by power; the slow stroke of the slotter working on nothing is visible; the planer running out of its cut for a dozen strokes on work ten feet long, can also be seen, and the fine feed and slow speed of the engine lathe keeps all the rest company. How not to do it in these shops seems to be a study, and, with this end in view, perfection has been achieved. What kind of a trade an apprentice could learn, and how long it would take to learn that kind in such shops is a conundrum, the answer to which may be supplied by any one capable.

Chordal's Letters in Book Form.

After repeated solicitations from many of our readers to publish "Extracts from Chordal's Letters" (which have been appearing in the AMERICAN MACHINIST for over two years) in book form, we have been moved to comply with these requests. We have in press and will shortly issue an artistically printed and fully illustrated 12 mo. volume of 320 pages, entitled "Extracts from Chordal's Letters." The book will contain the essential portions of these "extracts" up to a recent date. It will also contain a fine steel portrait of "Chordal," together with a characteristic preface written by him and signed *with his real name and address.* Over forty original illustrations by the talented caricature artist, Charles J. Taylor, are interspersed throughout the book. The native humor in which Chordal's writings abound has been caught and portrayed to the life by Mr. Taylor. Among the illustrations we may mention "The Lightning Machinist," "Our Artist Sketching a Common Boiler Front," "Ingraham's Opening Day," "The Yankee Contractor in Pete and Cady's Shop," "Shops on the Hatchway Plan," and many others abounding in humorous points. The paper on which the book will be printed is extra fine and heavy. The book will be handsomely bound in cloth with beveled edges and will be sold at the low price of $1.50 a copy, by mail postpaid, in order to place it within the reach of all. Its completion will be announced in these columns in time for the approaching holiday season.

Literary Notes.

THE STUDENT'S ILLUSTRATED GUIDE TO PRACTICAL DRAUGHTING.—A series of practical instructions for machinists, mechanics, apprentices and students at engineering establishments and technical institutes. By T. P. Pemberton, 5 Dey street, New York. $1.00.

The contents of this work, with the exception of a few chapters (or lessons), have already appeared in the AMERICAN MACHINIST in a series of articles entitled "Practical Draughting," by Mr. Pemberton. The book is printed in convenient form, and contains 112 pages, fully illustrated. In

the preface the author tersely remarks: "The fact cannot be too frequently reiterated that the education of the mechanic is incomplete without a thorough knowledge of mechanical drawing and other branches inseparably connected with it. There are many fine inventions and improvements which have been lost to the public from the inventor's inability to express his ideas upon the drawing board, and hundreds of machinists would be at this moment poring over their drawing boards—inventing, scheming and improving—had they studied and acquired a taste for practical draughting."

N. W. AYER & SONS' AMERICAN NEWSPAPER ANNUAL—containing a catalogue of American newspapers; a carefully prepared list of all newspapers and periodicals published in the United States, Territories and Dominion of Canada, with valuable information regarding their circulation, issue, date of establishment, political or other distinctive features, and advertising rates, together with the population of the cities and towns, as well as of the counties in which they are published; a list of all newspapers in the United States and Canada which insert advertisements, arranged by counties; also separate lists of all religious and agricultural publications, the various class publications, and all newspapers published in foreign languages, omitting those which do not insert advertisements. N. W. Ayer & Sons, Philadelphia.

The work bearing the above title first commends itself by reason of its neat typographic appearance, and a systematic and convenient arrangement of its contents. The advertisements are all grouped together, following the reading or directory part, none, small or large, being interspersed through the body of the work. The comparatively small portion of this work devoted to advertising shows that this part has not been the leading object of the publication.

We have taken some pains to give this book a thorough examination before expressing any opinion in regard to its merits, and though some errors and omissions have thereby been discovered, we are convinced that the publishers deserve credit for bringing out the fullest, most reliable and valuable work of the kind now before the public. We are informed that its preparation has involved an expense of over $10,000, necessitating the mailing of at least 40,000 circulars and personal letters during its compilation. The census of 1880 of counties, States, cities and towns is a prominent feature, and one that will be appreciated. In one list is given the population of nearly all the cities and towns of the United States having 10,000 or more inhabitants in 1870 and in 1880.

According to this Annual there are in the United States and Canada 10,647 newspapers and periodicals, divided into sections as follows: New England, 818; New York, 1,241; Middle States, 1,267; Southern States, 1,730; Western States, 4,855; Territories, 190; Canadian Provinces, 574. It is noticeable that while the circulations of most papers are given, this information is omitted in some cases, and in others the word "decline" is printed instead of the figures of the circulation. Where reliable data could not be obtained, instead of guessing at the circulation and asking the users of the book to accept the result as authority, the reader is left to do his own guessing. In looking over the tables of newspapers, grouped according to classes, we observe that of strictly mechanical papers the AMERICAN MACHINIST is credited with the largest weekly circulation, and the *American Miller*, Chicago, the largest monthly circulation.

The Industrial World, Chicago, is a live, enterprising, weekly journal, which gives a great deal of manufacturing information, together with market reviews and articles upon industrial topics. Commercial Advertiser Co., $3 a year.

The *American Journal of Industry*, Pittsburgh, Pa., is a finely printed weekly journal of industrial information. It gives full market reviews and quotations, together with a variety of interesting matter. Journal of Industry Co., $3.00 a year.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common sense methods.

(1.) A. G., Nashville, Ky., writes: I have occasion to use large quantities of shellac, and would like to have you inform me of a way to detect adulteration in shellac, also to test the purity of alcohol. *A.*—A good practical way to test shellac is to obtain some perfectly pure alcohol, known in commerce as "absolute," and dissolve some of the shellac to be tested into it. It should be well shaken occasionally, and at the expiration of about two days the solution should be filtered when the residue will show any adulteration. The alcohol will dissolve all of the pure shellac, but leave the impurities in suspension or as a precipitate. To test the purity of alcohol, place a hydrometer in it. If pure, the scale will indicate 1,000, but if the scale sinks only to 950 it would indicate that the spirit is 95 per cent. Alcohol may also be tested by burning a small quantity in a saucer. If the spirit is pure it will all burn, if not, the water or other adulterations will be left. Due allowance should be made for the evaporation of a portion of the residue caused by the heat of the pure spirit in burning.

(2.) H. S. B., Camden, N.J., writes: In a book entitled, "The Steam Engine Considered as a Heat Engine," by Jas. H. Cotterill, on the first page the author speaks of the Memoirs of the Institute of France. Is that volume published in the English language, and where can it be obtained, and what is it worth? *A.*—The book referred to has not yet been translated into the English language. The French edition can be obtained through any of the leading scientific book publishers and the translation made for a moderate consideration. The price of the book of course will be governed by the trouble involved in obtaining it.

(3) F. W., Sac City, writes: I am making a hydraulic press. What I wish to know first is: Does the ram or plunger need any packing, such as fibrous or rings? There is no force to act except that of the water from the pump. *A.*—Packing is not only required in your case, but, unless it is made in the best manner, it will leak. A stuffing box and gland may work for very low pressures, but we would not recommend its use. Leather is generally used, and is prepared by pressing a leather washer into a groove in an iron die, forming a ring, a section of which would represent in shape the letter **U**. This ring is placed in a recess within the opening that receives the ram, with the rounding part of the ring towards the opening. The pressure of water will then act upon the inside of the ring, pressing it against the ram and casting at the same time, thus making a tight and durable joint. 2. What size of cylinders will be required to drive a buggy to carry two persons? *A.*—To answer your question would involve the designing of a vehicle throughout, and until you send us a design of the diameter of wheels required, also, how the connections with the wheels and engine are to be made, we will be unable to give you any definite answer. To help you in designing we refer you to an illustration of a modern steam buggy in the AMERICAN MACHINIST of Oct. 30, 1880.

(4). C. P. F., Chicago, Ills., writes: I am an apprentice, and would be thankful for an answer to the following questions: 1. What is the best book on tempering die tools, and the various metals? *A.*—"The Management of Steel," by George Ede, is an excellent practical work for practical men. 2. Please name a book that would help a young thinker, or inventor; also, any books of importance for a young mechanic, particularly a die maker. *A.*—We would suggest that you procure "Knight's Mechanical Dictionary," and study it thoroughly; and for shop tools and manipulations, we refer you to "Harrison's Tool Book," which may be obtained from any dealer in scientific books. 3. Please tell me what will stop excessive sleepiness, morning and evening; it prevents me from studying. *A.*—Consult a reliable physician, and if your health is not impaired, the drowsiness is probably caused by the inactivity of your brain. We suggest that you eat light suppers, and study every evening; by perseverance and gradually increasing the exercise, you will suffer little or no inconvenience. It will require a pretty strong effort to wholly overcome the difficulty.

(5.) Andy, Charlotte, N. C., writes: If any of your readers can beat the time made in cutting screws let him speak up, or else, hereafter, hold his peace. Screw, 9 feet long; 1" pitch of thread; diameter of screw, 3 3-16"; bottom of thread 2⅛"; time, 1 hour and 46 minutes; cut in an ordinary slide rest lathe, made by Miles Tool Works. I can make an average of four a day. I bore cylinders with five cutters, sometimes three. A friend says he can bore as true a cylinder with one cutter as can be with more. I say he cannot on a slide rest. Who is right? *A.*—In boring cylinders it is best to use three cutters, although two will frequently do. When three are used the boring bar is well supported, and a straight, smooth hole of a uniform diameter is the result. It is impossible to accomplish the same result with a single cutter, particularly where a light boring bar is used, for the reason that the bar will spring, causing the hole to be smallest in the middle of the cylinder. The surface of the metal will also be the roughest at that point, for the same reason. The above statements are made referring to a boring bar having a sliding head. But where a single cutter is fastened into a slot in the bar, and the cylinder is bolted to the carriage of a lathe, as the cutter revolves it will be inclined to tip the cylinder, tipping and raising the carriage, whereas the same difficulties would be greatly, if not entirely, overcome by the use of three cutters, which would equalize the strain.

Business Specials.

50 cts. a line for each insertion under this head.

C. Spiro, Counselor at Law and Mechanical Expert. Specialty, Infringement suits. 10 Spruce St., N. Y.

Buerk Watchman Detector for sale. In perfect working order, Eight keys. Will be sold at a great bargain. F. McSwegan, 297 Water St., N. Y.

Vertical and Horizontal Pumps. Capacity from 100 to 35,000 galls. per minute. Simple, Efficient, Economical, Durable. Used by more than half the tanners and paper makers of the country. Horizontal and Vertical ENGINES, from 10 to 30 H. P., for long continued hard work. Prices, 40 per cent. below other makers. Send for circulars. Heald, Sisco & Co., Baldwinsville, N. Y.

Rules for Engineers, and Removal of Scale in Boilers. Send for Circular. Ranken Scale Co., 50 Federal Street, Boston.

Thomas D. Stetson, Patent Solicitor and Expert in Patent Cases, No. 23 Murray Street, New York.

Blowers for all purposes. Exeter Machine Works, 50 Federal Street, Boston.

See Christiana Machine Co.'s adver., next number.

We desire to correspond with persons having clean copies of the AMERICAN MACHINIST which they are willing to dispose of as follows: Vol. 1, Nos. 1, 2, 3, 9 and 11. Vol. 2. No. 2. American Machinist Publishing Co., 96 Fulton St., New York.

American Watch Tool Co., Waltham, Mass., Whitcomb Watch Makers' Lathes, and Watch Machinery.

Jenkins' Patent Gauge Cocks, the best in use. Send to A. W. Cadman & Co., Pittsburgh, Pa., for illustrated circular.

Manual of Power for Machines, Shafts, and Belts, with the History of Cotton Manufacture in the United States, by Samuel Webber, C. E., copyrighted 1879. Only work of the kind extant; 240 pages. Price $3. Address, the author, Manchester, N. H.

James W. See, Designing and Consulting Engineer, Hamilton, Ohio.

Howard S. Abbot, Attorney at Law and Solicitor of Patents, 617 7th Street, N. W., Washington, D. C. Personal attention given to cases in Patent Office.

Sheet Metal Presses. Ferracute Co., Bridgeton, N.J.

Engines Indicated—Power Measured. W. H. Odell, Box 274, Yonkers, N. Y.

John Douglass, common and fine patterns made to order, also car wheels, working models, and experimental machinery. Shop at 83 Morgan street, near Washington, Jersey City, N. J.

Paper Making Machinery—Makers of above from fibrous material as wood, esparto grass, etc., send address to Joshua Rose, P. O. Box 3306, N. Y. City.

"Monitor Binder" for the AMERICAN MACHINIST holds 52 weekly issues in good shape. Sent to any address by mail for one dollar. American Machinist Publishing Co., 96 Fulton St., New York.

Wilkinson & Crowell, No. 506 Walnut St., Philadelphia. "Paragon" Piston-rod Packing, entirely metallic, automatic, frictionless, and practically free of steam pressure. Will work on high-speed or condensing Engines.

MANUFACTURES.

The public may be interested in knowing that the Pullman Palace Car Company are not suffering ruinous loss in their business. The last accounting shows a revenue of $2,635,468 from all sources, with an expenditure of $955,047.

The Schenectady Locomotive Works are building some fast passenger engines for the N. Y. C. & H. R. R., having 18" x 24" cylinders, with drivers 6' 3" diameter.

John H. Vornbrook is rebuilding his large furniture factory, occupying an entire square, bounded by Webster, Chambers and Main Sts., and the Mississippi River, in St. Louis, Mo.

Ground has been broken for the erection of a new furniture factory at the corner of Green and Rigely streets, Chicago, by H. Halvorsen, formerly of Halvorsen, Johnson & Co. The building will be 47x100 feet, four stories high, and substantially built of brick. He will give employment to sixty men, and will have his machinery ready to start about January 1st.

The Chicago Coffin Company is a new organization, which will have a large factory in operation by January 1st. The company includes among its active promoters several men of ample means, and will start in with every facility necessary to make the venture a complete success. Mr. J. T. Richards, for eight years past with F. H. Hill & Co., will be the active man and general manager of the company.—*Am. Furniture Gazette.*

In speaking of car ventilation as it exists at present, the *National Car Builder* says: "An ordinary day car contains about 2,550 cubic feet of breathing space, which, divided among 60 passengers, gives each one about 43 cubic feet, or about the quantity contained in a box 3½ feet square;" this, it very justly remarks, is rather close quarters for any length of time, and it urges upon inventors the necessity of some adequate provision for equalizing the temperature automatically, as well as providing fresh air in passenger cars.

A Minneapolis, Minn., correspondent sends us the following: Machine business is good in our city in general. The North Star Works are rebuilding their pattern and store-room, destroyed a short time ago. The new firm have all they can do, employing more men than ever before at one time, and are running until 9 P. M.

The Chicago, Milwaukee & St. Paul Railroad Co., has proposed to erect large machine shops in Dubuque, Iowa, provided the city will give the necessary land and right of way.

The California Southern Railroad Co., has been incorporated at San Diego, Cal., to build a railroad from San Diego to San Bernardino, 116 miles, thence to some point of junction with the Atlantic & Pacific road. Surveys have been made, and material is on the way to construct the road, rails having been purchased in England. San Diego is to become the terminus of a trans-continental railroad within a year from January first.

Newly-Incorporated New York Companies.

The Onderdonk Manufacturing Company, Gravesend, Kings county, Robert Hewitt, Jr., Lansing Onderdonk and others, trustees. Capital, $100,000, in shares of $25 each. For the manufacture and sale of sewing machines and parts thereof, and of other light hardware. Filed Nov. 4th, 1880.

Kreamer Patent Scale Purgative Company, New York, Henry H. Kreamer, Charles Thiell and others, trustees. Capital. $100,000, in shares of $25 each. For the manufacture and sale of the Kreamer Patent Scale Purgative, and to sell rights to make and use the same. Filed Nov. 6th, 1880.

The Condensated Concrete Company, New York, J. Pierson Grant, Edward L. Stoddard and others, trustees. For the manufacture and sale of pavement, drain-pipe insulators and other articles made under Grant's patent, also to grant licenses to others to manufacture under said patent. Filed Nov. 6th, 1880.

The New York Steamboat Construction Company, Limited, New York, Henry S. Leavitt, Joseph A. Jenneson and others, incorporators. Capital, $5,000, in shares of $50 each. To purchase, construct, furnish, equip, maintain, navigate and sell steam boats and steam vessels, and transport passengers and freight. Filed Nov. 6th, 1880.

The Celluloid Photographic Company, New York, D. N. Carvalhoe, Samuel Blackwell and others, incorporators. Capital, $40,000, in shares of $50 each. For the manufacture and sale of photographic implements. Filed Nov. 9th, 1880.

Gray Brothers' Boot and Shoe Manufacturing Company, Syracuse, N. Y., H. H. Gray, John D. Gray and others, incorporators. Capital, $50,000, in shares of $100 each. For the manufacture and sale of boots and shoes. Filed Nov. 9th, 1880.

New York Tartar Company, Brooklyn, N. Y., Joseph C. Hougland, Wm. Ziegler and others, trustees. Capital, $30,000, in shares of $1,000 each. For the purpose of manufacturing and dealing in chemicals, including cream of tartar and kindred products. Filed Nov. 9th, 1880.

Machinists' and Engineers' Supplies.

NEW YORK, November 18, 1880.

There is nothing new to report in reference to the supply market this week. The transactions continue good for the season and prices are not likely to undergo any material change before the beginning of the new year.

Hammers, Sledges, and other steel forgings continue scarce.

The Providence Tool Co. have just issued full-sized blue prints of a full line of turnbuckles now manufactured by them. These prints give full details and dimensions, and are intended for circulation among dealers and consumers.

Iron Review.

NEW YORK, November 18, 1880.

The inquiries for pig iron are more numerous this week, and there is a fair business being done. However, the state of the market is not as lively as some of the dealers have anticipated. Prices have changed but very little. We quote as follows: Foundry No. 1, $25 @ $26; Foundry No. 2, $21, and Gray Forge, $20. Manufactured iron still remains unchanged.

Carmichael & Emmens, 130 Cedar St., New York, quote prices of Boiler Makers' Supplies from store unchanged.

Metal Review.

LUCIUS HART & CO., 8 & 10 Burling Slip, New York, furnish us the following, under date of Nov. 18, 1880:

We have to report an active and advancing market for metals. Pig Tin £91 in London, $28 in Singapore. More buyers than sellers. Quote spot market 25c. for Banca Tin, Straits and Malacca. 22c.; Australian and Billiton 21½c.; "Lamb & Flag," 21c; Lead rules 5c. to 5½c. as to lots, market dull. Antimony, 16½c. for Cookson; 15½c. for Hallet, Spelter, 5½c. for Domestic, and 8½c., "Bertha," pure; Solder, No. 1, 11½c.; "Half and Half," 13½c.; Bismuth, $2.50 to $3.00.

WANTED.

Parties desiring a competent man to superintend the erection of engines or machinery, address J. F. Kingsley, Box 777 Owego, Tioga Co., N. Y.

Wanted—Machinists—Six strictly first-class Vise hands and Fitters accustomed to building machine tools; liberal wages paid by Niles Tool Works, Hamilton, Ohio.

Situation by a Machinist and Draughtsman. Address, L. R. Burns, Port Chester, N. Y.

A young married man of good moral character and worthy of confidence, wants a steady situation to run a blast engine. Address, "Lehigh," care AMERICAN MACHINIST, 96 Fulton street, N. Y.

Wanted.—Parties wishing to engage a Foreman Machinist with first-class reference may address, J. M., AMERICAN MACHINIST Office.

By a Mechanical Engineer well known professionally, thoroughly capable in practical shop details, designing and draughting. The best references to character and ability. Address, H. K, 34 Park Row, Room 33.

Situation Wanted.—By a Mechanical Engineer, who can attend to office work as well as to anything done in the workshop. Address, H. K., AMERICAN MACHINIST.

A competent Engineer is open for an engagement. Can give the best of references as to character, sobriety and ability. Understands running electric lights. Address, J. M., Box 701. N Y. Post Office.

ENGINE BUILDERS

Who purpose changing their styles and building first-class

Automatic Cut-off Engines

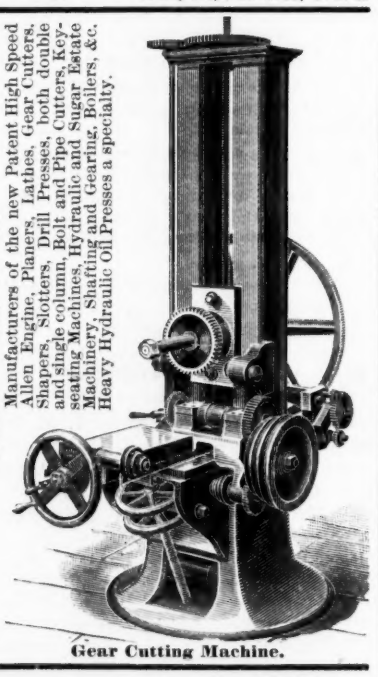
can hear of an experienced and reliable Designer and Superintendent by addressing M. E., Office of this paper.

GEO. W. FIFIELD,
Manufacturer of **ENGINE LATHES** from 16 to 48 in. swing. Cuts, Photographs and Prices furnished on application.
LOWELL, MASS., U. S. A.

Monitor Binders FOR THE **American Machinist,**
$1.00 EACH BY MAIL OR EXPRESS.

STEPHENS' PATENT PARALLEL VISE and attachments, adapted to every variety of work from Jewelers' to Locomotive Shops. It opens **further,** holds **firmer,** is **heavier** and more **durable** than any other vise. For sale by the trade.
Stephens' Patent Vise Co
41 Dey St., New York, U. S. A

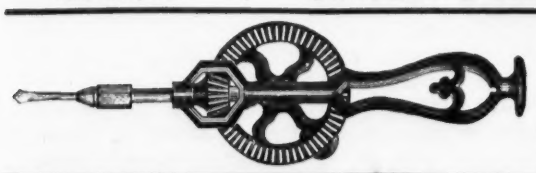
HEWES & PHILLIPS' IRON WORKS,
NEWARK, N. J.
Manufacturers of the new Patent High Speed Allen Engine, Planers, Lathes, Gear Cutters, Shapers, Slotters, Drill Presses, both double and single column, Bolt and Pipe Cutters, Key-seating Machines, Hydraulic and Sugar Estate Machinery, Shafting and Gearing, Boilers, &c. Heavy Hydraulic Oil Presses a specialty.



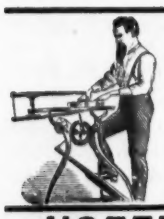
Gear Cutting Machine.

Branch Office,
46 & 48 WEST LAKE STREET, CHICAGO, ILL.

BRADLEY'S CUSHIONED HELVE HAMMER.
Awarded first premium, Silver Medal at American Institute Fair, 1873, Cincinnati Industrial Exposition, 1874, and the Diploma of Honor and Grand Medal of Merit at the Centennial Exhibition, in 1876,
Being the highest award given any goods of their class in America or Europe.
IT HAS MORE GOOD POINTS, LESS COMPLICATION,
MORE ADAPTABILITY, LARGER CAPACITY,
DOES MORE AND BETTER WORK, TAKES LESS POWER,
COSTS LESS FOR REPAIRS
THAN ANY HAMMER IN THE WORLD.
Guaranteed as represented. (Established 1832.)
BRADLEY & COMPANY, Syracuse, N. Y.



THIS PATENT
HAND DRILL STOCK,
Eight inches long, having a Brass Chuck and Six Diamond Drill Points of various sizes, all of which fit the chuck, is sent by mail, per-paid, on rece pt of sixty cents. It is a perfect tool, and worth much more than it costs.
MILLER'S FALLS CO.
74 Chambers St., New York.



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Complete Outfits.
LATHES for METAL or WOOD
Circular Saws, Scroll Saws, Formers,
Mortisers, Tenoners, Etc., for Actual Workshop Business. Machines ON TRIAL if desired. Mention this paper, and send for Descriptive Catalogue & Price List.
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Relating to Casting and Founding, Electricity, Electric Light, Engineering, Drawing, Manufacture of Gas, Heat, Indicator Diagram, Link Motion, Mechanics, Screw Cutting, Slide Valve, Steam Boilers, Steam Engines, Steel, Turning, Wire Gauge, Workshop Receipts. Descriptive Catalogue sent promptly on application.
E. & F. N. Spon, 446 Broome St., N. Y.

T. NEW'S PREPARED
ROOFING.

For steep or flat roofs. Applied by ordinary workmen at one-third the cost of tin. Circulars and samples free. Agents Wanted. T. NEW, 38 John Street, New York.

WILLIAM COOKE,

(Successor to COOKE & BEGGS),
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AGENT FOR
The Waters Perfect Governor,
Having Adjustable Speed, Automatic Safety Stop, Sawyer's Lever, and Solid Composition Valves and Seats.

ALSO, DEALER IN
SUPPLIES
For Machinists,
Railways, Mills,
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Please send for circular and state that you saw the advertisement in this paper.

FILE SHARPENING by Sand Blast Process
SIMPLE, INEXPENSIVE AND EFFECTIVE.
Files are sharpened in a few minutes without drawing or disturbing the temper.
The teeth are made sharp and in the best shape for cutting without breaking.
Practical experience shows an *immense saving in Files* and *great increase in work* by always having them sharp. For shop rights, in country south and west of New York State, and for further information, address
Sand Blast File Sharpening Co., Wilmington, Del.

MORSE TWIST DRILL & MACHINE COMPANY,

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Sole Manufacturers of
MORSE PATENT STRAIGHT-LIP INCREASE TWIST DRILL,
Beach's Patent Self-Centering Chuck, Solid & Shell Reamers.
BIT STOCK DRILLS,
Drills for Coes, Worcester, Hunter and other Hand Drill Presses. Beach's Patent Self-Centering Chucks, Center and Adjustable Drill Chucks, Solid and Shell Reamers, Drill Grinding Machines. Taper Reamers, Milling Cutters and Special Tools to order.
All Tools Exact to Whitworth Standard Gauges.
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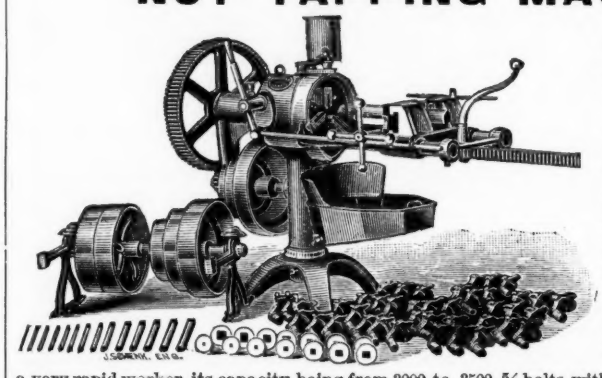
HOWARD IRON WORKS, BUFFALO, N. Y.

MANUFACTURERS OF
Schlenker's Revolving-Die Bolt Cutter
AND
NUT TAPPING MACHINE.



OUR NEW REVOLVING-DIE MACHINE is now recognized by practical machinists to be the perfection of a Screw Cutting Machine, and we now challenge the world to produce its equal. It possesses many advantages over any competitor. The dies are opened automatically when the desired length of thread has been cut on the bolt, and are closed by the lever, or automatically, as shown in the cut of the machine. It can be changed from one size to another in less than a minute without removing a bolt or pin. It does not require skilled labor, but can be operated by any competent boy. The dies are arranged to open and close automatically, therefore do not require the constant attention of the operator. It is a very rapid worker, its capacity being from 3000 to 3500 ⅝ bolts with 1¼ inches of thread per day—and larger bolts in proportion. Threads cut by these machines will not vary ⅛ thread in length on ten thousand bolts. The machines are simple in construction, very compact and strongly built, and are offered much below the price of any other machines capable of cutting the same sizes, and amount of work. It is adapted to cut right and left hand, V thread, square threads, and coach screws,—will take in crooked as well as straight work, and cut any length of bolt. The machines are now largely in use, and we offer them to the trade as one of the most complete machinists' tools in the market. Every machine is warranted as recommended.

HOWARD IRON WORKS, Buffalo, N. Y.
Illustrated Catalogue sent on Application.

KEARNEY & FOOT

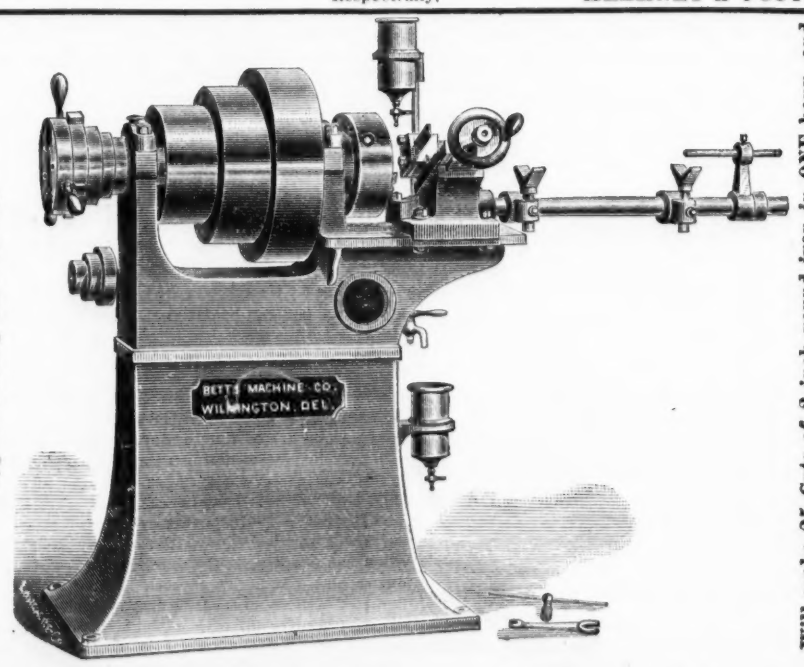
Office, No. 78 Chambers Street, N. Y. — **Full Weight Hand-Cut Files.** — Manufactory, PATERSON, N. J.

The best and cheapest in the end. Send for quotations. The files speak for themselves in the following testimonials. Read them.

Messrs. KEARNEY & FOOT, Brooklyn, N. Y., May 24th, 1877.
Gentlemen:—We have used your Files, more or less, for several years, and we take pleasure in saying that both the new and re-cut Files have given entire satisfaction. Yours truly,
BLISS & WILLIAMS.

FARREL FOUNDRY AND MACHINE CO.
JAS. D. FOOT, Esq., Waterbury, Conn., Nov. 8th, 1878.
Dear Sir:—Please forward the order for Files given you a few days since.
Your Files have been uniformly satisfactory to us. Yours respectfully,
FARREL FOUNDRY & MACHINE CO., E. C. LEWIS, Ag't.

We print instructions on the use of Files, and also give the diameters of round and square Files from 3 to 16 inches. They are on card board, 10x12 in., and are intended to be put up in the shop for the men to read. We are pleased to mail them to any manufacturer on receipt of the necessary 6 cents postage.
Respectfully, **KEARNEY & FOOT.**



2½ in. Cutting-Off Machine.

Will make 25 Cuts of 2 inch round iron in ONE hour, and leave the ends in FIRST RATE condition.

BETTS MACHINE CO., Wilmington, Del.

NICHOLSON FILE CO.

SOLE MANUFACTURERS OF

FILES AND RASPS

HAVING THE INCREMENT CUT.

Also, FILERS' TOOLS and SPECIALTIES.

"Nicholson File Co's" Files and Rasps.
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NEWARK STEEL WORKS.

BENJAMIN ATHA & CO.

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WE MAKE GRADES OF STEEL SPECIALLY ADAPTED TO THE MANUFACTURE OF LATHE TOOLS, CHISELS, TAPS & DIES

BENJ. ATHA. NEWARK, NEW JERSEY. J. ILLINGWORTH.

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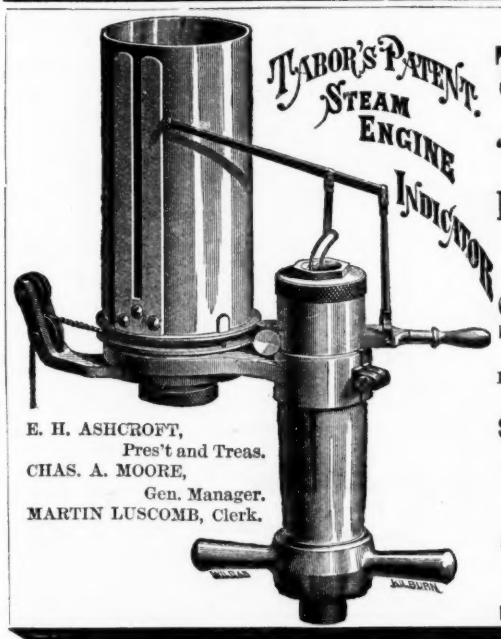

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Successors to E. H. ASHCROFT,

"Original Steam Gauge Works."

THE E. H. ASHCROFT

Improved "Bourdon" Steam Gauges.

Sole Owners and Manufacturers of

TABOR'S PATENT

STEAM ENGINE INDICATORS.

Specially adapted to

Indicating High Speed Engines and Locomotives.

STEAM AND WATER GAUGES,

Railway, Steamship & Machinery Supplies.

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CAST JACK SCREWS,

With perfect, seamless thread, and hard wearing surface. Special mixture of tough iron. Superior to wrought iron in many respects, and **much cheaper.**

N. B.—Our No. 2 "Handy Bell Jack," 8x1¼ inch, **Price, $2.00,** (see Cut) has lifted 10 tons (

Send for circular.

SEEGER MF'G CO.

MAKERS OF

Press, Stool & Bench Screws,

CLAMPS, &c.

Box 878. Springfield, Mass.

Over 1000 of these Turbines in operation in this and Foreign countries.

BURNHAM'S STANDARD.

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Tight shutting and easily operated gate. Large Pamphlet mailed free.

AKRON IRON COMPANY,

AKRON, O.

SOLE MANUFACTURERS OF

Patent Hot Polished Shafting.

This shafting commends itself to the trade generally as superior to any shafting ever before introduced to the market for the following reasons, viz.:

1st.—It is perfectly straight and round.

2d.—It can be rolled accurately to any desired gauge.

3d.—It has the beautiful blue finish of Russia Sheet Iron, rendering it less liable to rust or tarnish than shafting of the ordinary finish.

4th.—It will NOT SPRING OR WARP IN KEY SEATING like most of the other manufactured shafting sold in the market, and, as a consequence, is admirably adapted for LINE AND COUNTER SHAFTING.

5th.—The surface is composed of MAGNETIC OXIDE OF IRON, forming a superior journal or bearing surface.

6th.—It is made of superior stock.

Sizes made from ¾ inch to 3 inches, advancing by sixteenths, and from 3 inches to 4 inches, advancing by eighths. Price lists, with references and other information, furnished on application to us.

Or to our Agent, **AKRON IRON CO., Akron, Ohio.**

E. P. BULLARD, 14 Dey Street, New York City,

General Agent for N. Y. City and other Eastern States.

DEANE'S PATENT STEAM PUMPS

FOR SIMPLICITY OF MECHANISM

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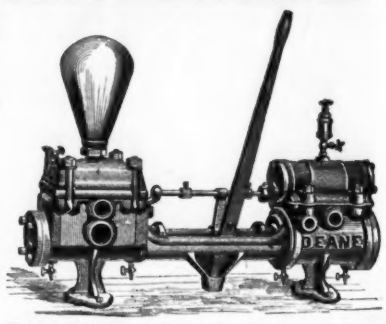

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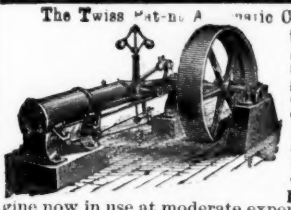

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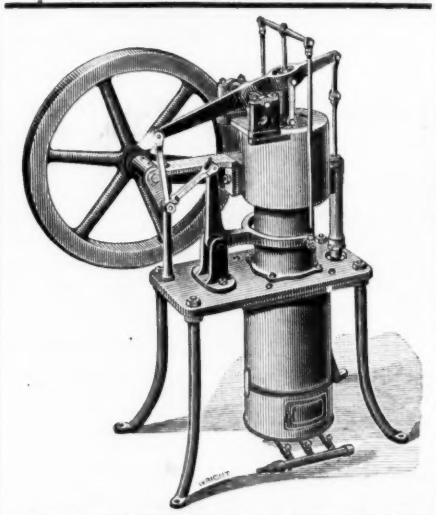

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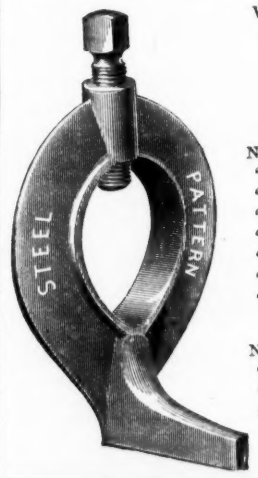

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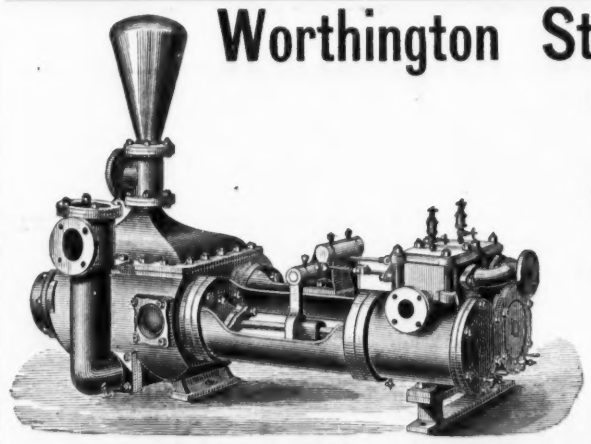

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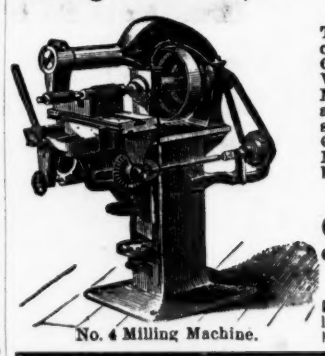

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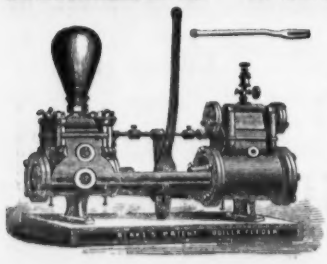

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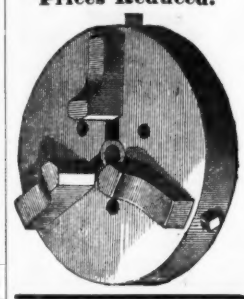

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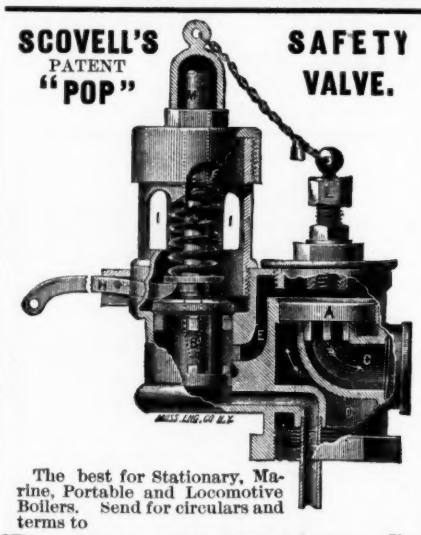

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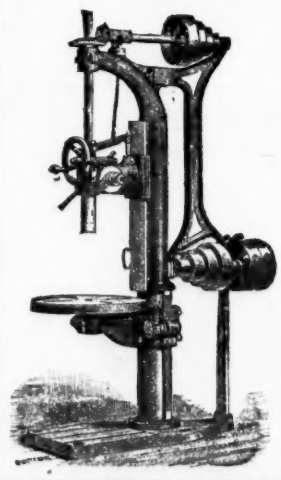

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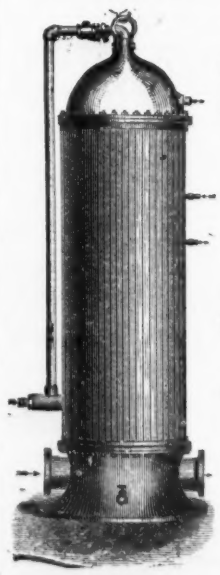

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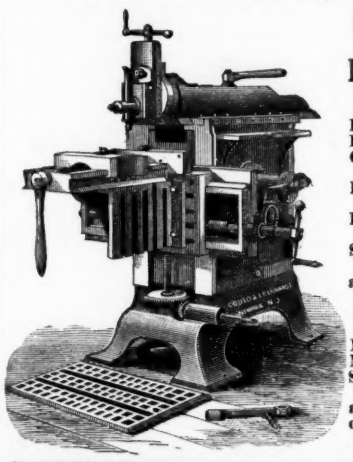

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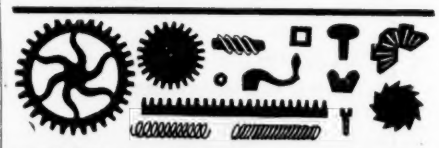

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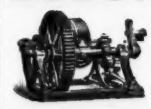

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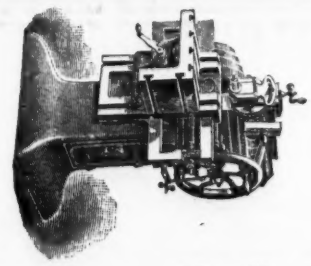

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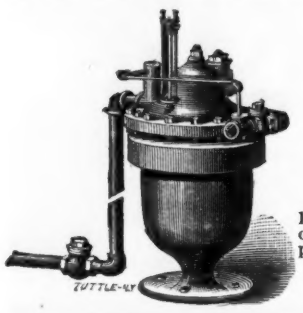

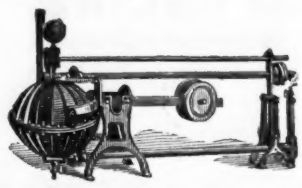

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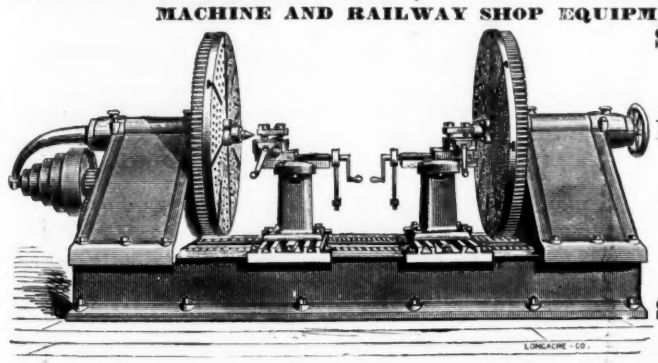

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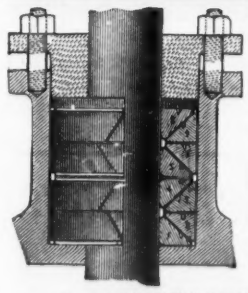

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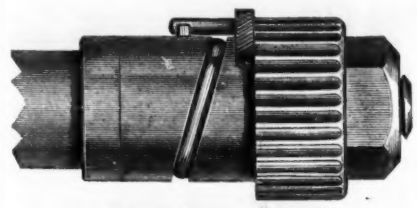

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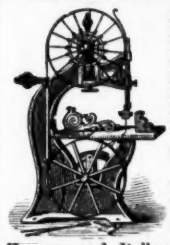

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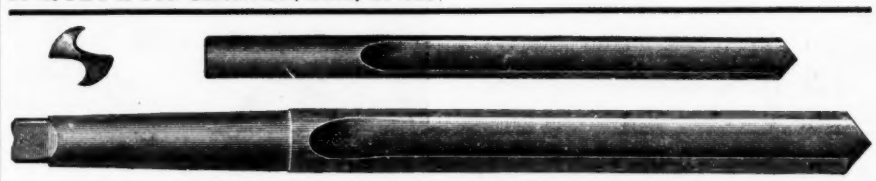

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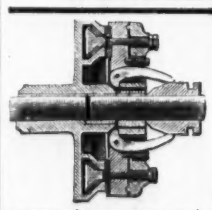

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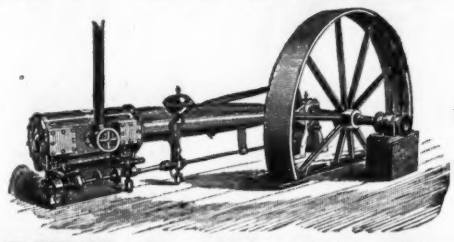

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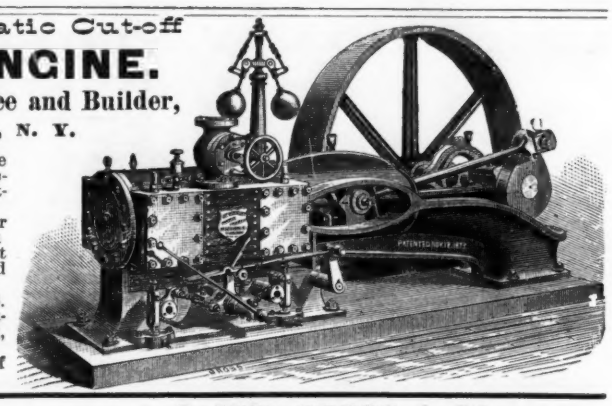

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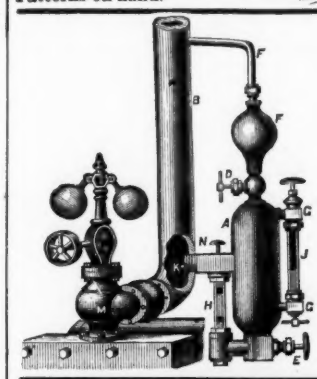

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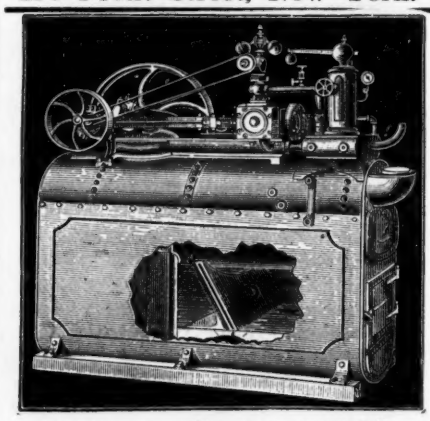

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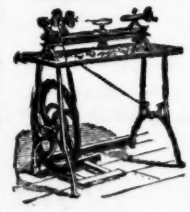

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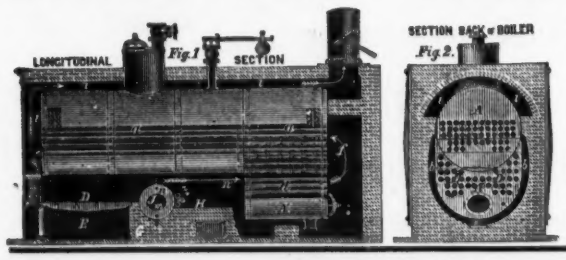

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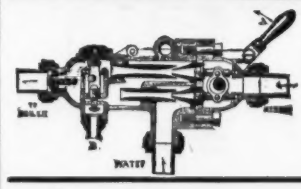

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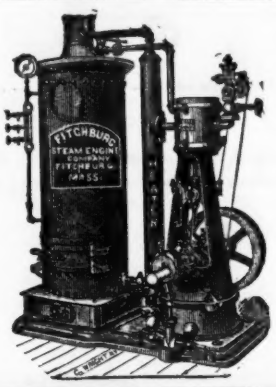

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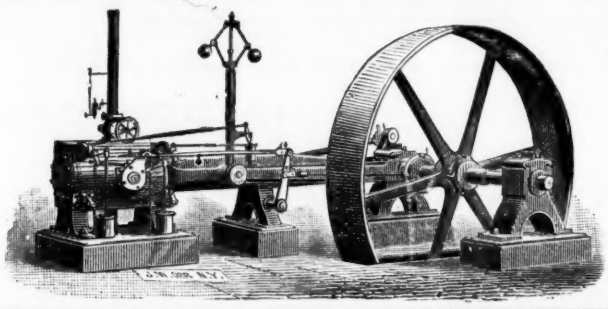

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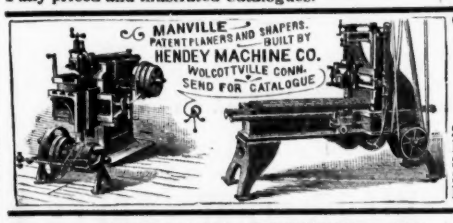

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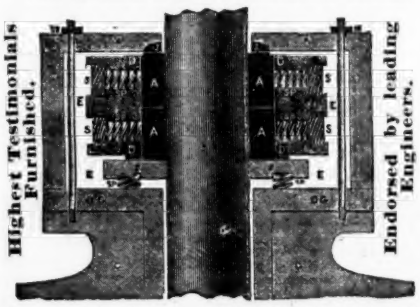

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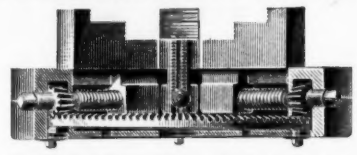

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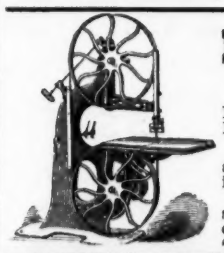

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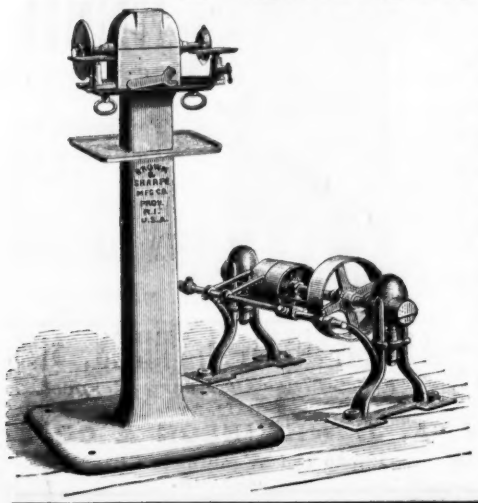

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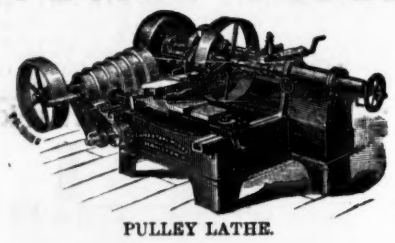

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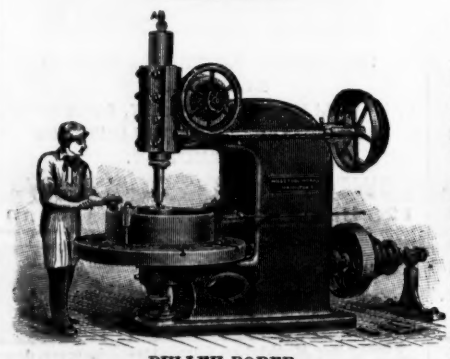

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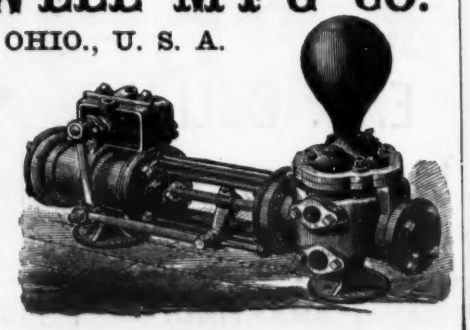

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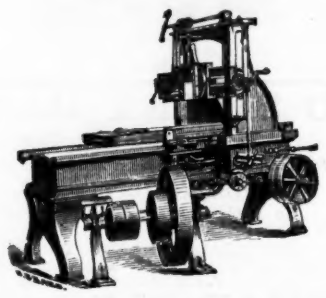

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